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# AEROSPACE MEDICINE AND BIOLOGY

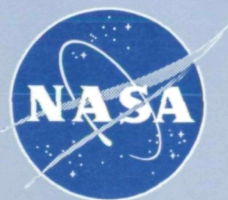
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NASA SP-7011 (408)

December 1995

# **AEROSPACE MEDICINE AND BIOLOGY**

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National Aeronautics and Space Administration  
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Washington, DC

1995

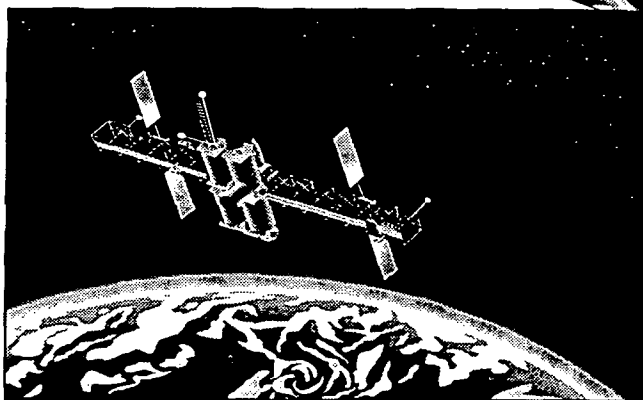
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# INTRODUCTION

This issue of *Aerospace Medicine and Biology* (NASA SP-7011) lists 84 reports, articles, and other documents recently announced in the NASA STI Database. The first issue of *Aerospace Medicine and Biology* was published in July 1964.

Accession numbers cited in this issue include:

<i>Scientific and Technical Aerospace Reports (STAR)</i> (N-10000 Series)	N95-32373 — N95-34822
Open Literature (A-60000 Series)	A95-95939 — A95-96758

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which humans are subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Applied research receives the most emphasis, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations include the original accession numbers from the NASA STI Database.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1995 will be published in early 1996.

The NASA CASI price code table, addresses of organizations, and document availability information are located at the back of this issue.



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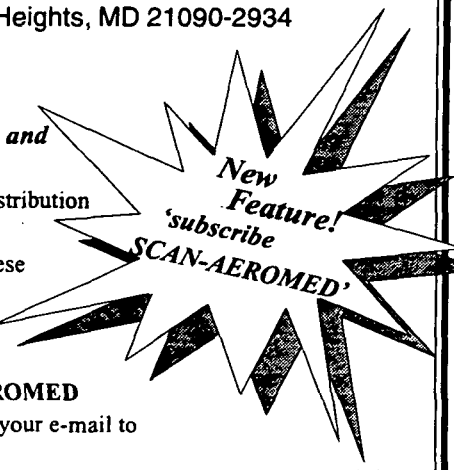
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ON MICROFICHE

This paper reports the results of a pilot study in which a 240-gm rat was implanted for 41 days with biotelemetry devices weighing a total of 36 gm (18 cc). The implanted animal showed no differences in weight gain, food and water consumption, and postnecropsy organ weights when compared to both an unoperated control animal and an animal that underwent surgery but did not receive an implant. The implanted animal also had temperature and activity rhythms similar to those reported using much smaller implants. Thus, this pilot study showed that a 240-gm rat could be implanted with biotelemetry devices weighing nearly 15 percent of body weight without significant changes in health or behavior. A larger study involving more animals and similar implant sizes is recommended.

Author

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This is a discussion of the beginnings of the International Society for the Study of the Origin of Life (ISSOL)—how it came to be and the people responsible for it. It will include the early meetings on the subject of the Origin of Life which led to the formation of the Society. It will discuss the genesis of the interest of NASA in such a program and how the Exobiology Program got started, leading up to the Viking Program and the early exploration of Mars. Photographs of early meetings and the scientists involved will be included. Author (Herner)



# AEROSPACE MEDICINE AND BIOLOGY

*A Continuing Bibliography (Suppl. 408)*

December 1995

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## LIFE SCIENCES (GENERAL)

A95-96275

### DENTAL RESTORATIVE MATERIAL-TOOTH INTERFACES

SALLY J. MARSHALL Univ of California, San Francisco, CA, United States, GRAYSON W. JR. MARSHALL, JOHN H. KINNEY, and MEHDI BALOOCH Scripta Metallurgica et Materialia (ISSN 0956-716X) vol. 31, no. 8 October 15 1994 p. 983-988 refs (BTN-94-EIX94522406268) Copyright

The interface between the tooth and a restorative element is crucial to the quality of restoration. Secondary dental caries may ensue at the site of interface if the restorative material is ineffective. Current research is being made on developing new techniques to enhance bonding composites to dentin. Amalgam bonding is of particular interest since this might promote impenetrability to secondary caries thereby strengthening its durability. EI

N95-32719\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

### MINUTES OF THE 12TH JOINT NASA/DARA-DLR LIFE SCIENCES PROGRAM WORKING GROUP MEETING Final Report

RONALD J. WHITE 1994 234 p Meeting held in Moffett Field, CA, 26-27 Oct. 1994 (NASA-TM-110655; NAS 1.15:110655) Avail: CASI HC A11/MF A03

This report contains the final minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting and includes the presentations made by participants. For individual titles, see N95-32720 through N95-32731.

### N95-32720\*# Siegen Univ., (Germany). Dept. of Physics. PROTON-INDUCED FRAGMENTATION OF CARBON AT ENERGIES BELOW 100 MEV

M. SCHMITZ, T. STREIBEL, H. ROECHER, J. DREUTE, S. E. HIRZEBRUCH, G. HUENTRUP, and WOLFGANG HEINRICH In NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 1-3 1994

Avail: CASI HC A01/MF A03

Radiation effects caused by single cosmic ray particles have been studied for many years in radiobiological experiments for different biological objects and biological end-points. Additionally, single event effects in microelectronic devices have gained large interest. There are two fundamental mechanisms by which a single particle can cause radiation effects. On the one hand, a cosmic ray ion with high linear energy transfer can deposit a high dose along its path. On the other hand, in a nuclear collision, a high dose can be deposited by short range particles emitted from the target nucleus. In low earth orbits a large contribution to target fragmentation events originates from trapped protons which are encountered in the South Atlantic Anomaly. These protons have energies up to a few hundred MeV. We study the fragmentation of C, O and Si nuclei - the target nuclei of biological material and microelectronic devices - in nuclear collisions.

Our aim is to measure production cross sections, energy spectra, emission directions and charge correlations of the emitted fragments. The present knowledge concerning these data is rather poor. M. Alurralde et al. have calculated cross sections and average energies of fragments produced from Si using the cascade-evaporation model. D.M. Ngo et al. have used the semiempirical cross section formula of Silberberg and Tsao to calculate fragment yields and the statistical model of Goldhaber to describe the reaction kinematics. Cross sections used in these models have uncertainties within a factor of two. Our data will help to test and improve existing models especially for energies below 300 MeV/nucleon. Charge correlations of fragments emitted in the same interaction are of particular importance, since high doses can be deposited if more than one heavy fragment with a short range is produced. Derived from text

N95-32722\*# Justus Liebig-Univ., Giessen (Germany). Cell and Radiation Biophysics.

### ESTIMATION OF SPATIALLY RESTRICTED LET USING TRACK STRUCTURE MODELS

J. KIEFER In NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 11-13 1994

Avail: CASI HC A01/MF A03

The spatial distribution of energy deposition is an important determinant in the formation of biologically significant lesions. It has been widely realized that Linear Energy Transfer (LET) being an average quantity is not sufficient to describe the situation at a submicroscopic scale. To remedy this to some extent 'energy-cut-off' values are sometimes used but since they are related to secondary electron energy and only indirectly to their range they are also not adequate although they may be easily calculated. 'Range-restricted LET' appears to be better but its determination is usually quite involved. Xapsos (1992) suggested a semi-empirical approximation based on a modified Bethe-formula which contains a number of assumption which are difficult to verify. A simpler and easier way is to use existing beam-models which describe energy deposition around an ion's path. They all agree that the energy density (i. e., energy deposited per unit mass) decreases with the inverse square of the distance from the track center. This simple dependence can be used to determine the fraction of total LET which is deposited in a cylinder of a given radius. As an example our own beam model. Energy density depends on distance  $x$  (measured in m) from the track center according to the presented formula. Derived from text

N95-32723\*# Justus Liebig-Univ., Giessen (Germany). Cell and Radiation Biophysics.

### HEAVY ION INDUCED DNA-DSB IN YEAST AND MAMMALIAN CELLS Status Report

M. LOEBRICH, S. IKPEME, and J. KIEFER In NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 15-17 1994

Avail: CASI HC A01/MF A03

Molecular changes at the DNA are assumed to be the main cause for radiation effects in a number of organisms. During the course of the last decades techniques have been developed for measuring DNA double-strand breaks (dsb), generally assumed to

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be the most critical DNA lesions. The outcome of all those different approaches portrays a collection of data useful for a theoretical description of radiation action mechanisms. However, in the case of heavy ion induced DNA dsb the picture is not quite clear yet and further projects and strategies have to be developed. The biological systems studied in our group are yeast and mammalian cells. While in the case of yeast cells technical and methodical reasons highlight these organisms mammalian cells reach greater importance when dsb repair studies are performed. In both types of organisms the technique of pulsed-field gel electrophoresis (PFGE) is applied, although with different modifications and evaluation procedures mainly due to the different genome sizes. Derived from text

**N95-32724\*#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Radiation Biology Div.  
**INACTIVATION, DNA DOUBLE STRAND BREAK INDUCTION AND THEIR REJOINING IN BACTERIAL CELLS IRRADIATED WITH HEAVY IONS**

M. SCHAEFER, H. ZIMMERMANN, and C. SCHMITZ *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 18-22 1994  
Avail: CASI HC A01/MF A03

Besides inactivation one of the major interests in our experiments is to study the primary damage in the DNA double strand breaks (DSB) after heavy ion irradiation. These damages lead not only to cell death but also under repair activities to mutations. In further experiments we have investigated the inactivation with two different strains of *Deinococcus radiodurans* (R1, Rec 30) and the induction of DSB as well as the rejoining of DSB in stationary cells of *E. coli* (strain B/r) irradiated with radiations of different quality. In the latter case irradiations were done so that the cell survival was roughly at the same level. We measured the DSB using the pulse field gelelectrophoresis which allows to separate between intact (circular) and damaged (linear) DNA. The irradiated cells were transferred to NB medium and incubated for different times to allow rejoining. Derived from text

**N95-32725\*#** Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany). Biophysics Group.

**DNA-DSB IN CHO-K1 CELLS INDUCED BY HEAVY-IONS: BREAK REJOINING AND RESIDUAL DAMAGE (GSI)**

G. TAUCHER-SCHOLZ, J. HEILMANN, G. BECHER, and G. KRAFT *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 23-25 1994

Avail: CASI HC A01/MF A03

DNA double strand breaks (DSB's) are the critical lesions involved in cellular effects of ionizing radiation. Therefore, the evaluation of DSB induction in mammalian cells after heavy ion irradiation is an essential task for the assessment of high-LET radiation risk in space. Of particular interest has been the question of how the biological efficiency for the cellular inactivation endpoint relates to the initial lesions (DSBs) at varying LETs. For cell killing, an increased Relative Biological Efficiency (RBE) has been determined for highLET radiation around 100-200 keV/mu m. At higher LET, the RBE's decrease again to values below one for the very heavy particles. At GSI, DSB-induction was measured in CHO-K1 cells following irradiation with accelerated particles covering a wide LET range. The electrophoretic elution of fragmented DNA out of agarose plugs in a constant electrical field was applied for the detection of DSB's. The fraction of DNA retained was determined considering the relative intensities of ethidium bromide fluorescence in the well and in the gel lane. Dose-effect curves were established, from which the RBE for DSB induction was calculated at a fraction of 0.7 of DNA retained. In summary, these rejoining studies are in line with an enhanced severity of the DNA DSB's at higher LET's, resulting in a decreased repairability of the induced lesions. However, no information concerning the fidelity of strand breaks rejoining is provided in these studies. To assess correct rejoining of DNA fragments an experimental system involving individual DNA hybridization bands has been set up. In preliminary experiments Sal I generated DNA fragments of 0.9 Mbp

were irradiated with xrays and incubated for repair. However, restoration of the original signals was not observed, probably due to the high radiation dose necessary for breakage of a fragment of this size. A banding pattern with NotI hybridization signals in a higher MW range (3Mbp) has been obtained by varying the electrophoretic conditions and correct rejoining studies will be further developed in this system. Derived from text

**N95-32726\*#** Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany). Biophysics Group.  
**CHROMOSOMAL DAMAGE OBSERVED IN FIRST POSTIRRADIATION METAPHASES OF REPAIR-PROFICIENT AND -DEFICIENT CELL LINES**

S. RITTER, W. KRAFT-WEYRATHER, K. FUSSEL, E. KEHR, and G. KRAFT *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 26-27 1994

Avail: CASI HC A01/MF A03

Investigation of radiation induced damage in mutant strains of mammalian cells which show a defect in the rejoining of DNA double strand breaks provides an unique opportunity to examine the role of double strand breaks and the mechanisms of double strand break rejoining in the production of chromosome aberrations. This is particularly important, because there is increasing evidence that the DNA double strand break is the major lesion responsible for the formation of chromosome aberrations. To address this issue, we studied the induction of chromosome aberrations in xrs-5 cells, an x-ray sensitive strain of a Chinese hamster ovary cell line, which shows a defect in the rejoining of double strand breaks and their wild-type parent CHO-cells. Because radiosensitivity depends strongly on cellular age, the experiments were performed with synchronous cells. Derived from text

**N95-32727\*#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Radiation Biology Div.  
**MUTATION INDUCTION IN BACTERIA AFTER HEAVY ION IRRADIATION**

G. HORNECK and S. KOZUBEK (Ceskoslovenska Akademie Ved, Brno.) *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 28-29 1994

Avail: CASI HC A01/MF A03

From a compilation of experimental data on the mutagenic effects of heavy ions in bacteria, main conclusions have been drawn as follows: (1) The mutagenic efficacy of heavy ions in bacteria depends on physical and biological variables. Physical variables are the radiation dose, energy and charge of the ion; the biological variables are the bacterial strain, the repair genotype of bacteria, and the endpoint investigated (type of mutation, induction of enzymes related to mutagenesis); (2) The responses on dose or fluence are mainly linear or linear quadratic. The quadratic component, if found for low LET radiation, is gradually reduced with increasing LET; (3) At low values of Z and LET the cross section of mutation induction sigma m (as well as SOS response, sigma sos, and lambda phage induction, sigma lambda versus LET curves can be quite consistently described by a common function which increases up to approximately 100 keV/mu m. For higher LET values, the sigma(m) versus LET curves show the so-called 'hooks' observed also for other endpoints; (4) For light ions (Z is less than or equal to 4), the cross sections mostly decrease with increasing ion energy, which is probably related to the decrease of the specific energy deposited by the ion inside the sensitive volume (cell). For ions in the range of Z = 10, sigma(m) is nearly independent on the ion energy. For heavier ions (Z is greater than or equal to 16), sigma(m) increases with the energy up to a maximum or saturation around 10 MeV/u. The increment becomes steeper with increasing atomic number of the ion. It correlates with the increasing track radius of the heavy ion; (5) The mutagenic efficiency per lethal event changes slightly with ion energy, if Z is small indicating a rough correlation between cellular lethality and mutation induction, only. For ions of higher Z this relation increases with energy, indicating a

change in the 'mode' of radiation action from 'killing-prone' to 'mutation-prone'; and (6) Repair genotype substantially influences the radiation induced mutagenesis. Different mechanisms of mutation induction and/or different types of biologically significant lesions in wild type cells compared to repair deficient strains are a likely explanation. Derived from text

**N95-32728\*#** Justus Liebig-Univ., Giessen (Germany). Cell and Radiation Biophysics.

**HEAVY ION INDUCED MUTATIONS IN MAMMALIAN CELLS: CROSS SECTIONS AND MOLECULAR ANALYSIS Status Report**

U. STOLL, P. SCHMIDT, E. SCHNEIDER, and J. KIEFER *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 30-32 1994  
 Avail: CASI HC A01/MF A03

Our investigations of heavy ion-induced mutations in mammalian cells, which had been begun a few years ago, were systematically continued. For the first time, it was possible to cover a large LET range with a few kinds of ions. To do this, both UNILAC and SIS were used to yield comparable data for a large energy range. This is a necessary condition for a comprehensive description of the influence of such ion parameters as energy and LET. In these experiments, the induced resistance against the poison 6-thioguanin (6-TG), which is linked to the HPRT locus on the genome, is being used as mutation system. In addition to the mutation-induction cross-section measurements, the molecular changes of the DNA are being investigated by means of Multiplex PCR ('Polymerase Chain Reaction') gene amplification. From these experiments we expect further elucidation of the mutation-inducing mechanisms composing the biological action of heavy-ion radiation.

Derived from text

**N95-32729\*#** Justus Liebig-Univ., Giessen (Germany). Cell and Radiation Biophysics.

**HEAVY ION ACTION ON SINGLE CELLS: CELLULAR INACTIVATION CAPABILITY OF SINGLE ACCELERATED HEAVY IONS**

M. KOST, H.-D. PROSS, C. RUSSMANN, E. SCHNEIDER, J. KIEFER, G. KRAFT (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt, Germany.), G. LENZ (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt, Germany.), and W. BECHER (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt, Germany.) *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 33-35 1994  
 Avail: CASI HC A01/MF A03

Heavy ions (HZE-particles) constitute an important part of radiation in space. Although their number is small the high amount of energy transferred by individual particles may cause severe biological effects. Their investigation requires special techniques which were tested by experiments performed at the UNILAC at the GSI (Darmstadt). Diploid yeast was used which is a suitable eucaryotic test system because of its resistance to extreme conditions like dryness and vacuum. Cells were placed on nuclear track detector foils and exposed to ions of different atomic number and energy. To assess the action of one single ion on an individual cell, track parameters and the respective colony forming abilities (CFA) were determined with the help of computer aided image analysis. There is mounting evidence that not only the amount of energy deposited along the particle path, commonly given by the LET, is of importance but also the spatial problem of energy deposition at a submicroscopical scale. It is virtually impossible to investigate track structure effects in detail with whole cell populations and (globally applied) high particle fluences. It is, therefore, necessary to detect the action of simple ions in individual cells. The results show that the biological action depends on atomic number and specific energy of the impinging ions, which can be compared with model calculations of recent track structure models. Derived from text

**N95-32730\*#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Radiation Biology Div.

**COSMIC HEAVY ION TRACKS IN MESOSCOPIC BIOLOGICAL TEST OBJECTS**

R. FACIUS *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 36-40 1994  
 Avail: CASI HC A01/MF A03

Since more than 20 years ago, when the National Academy of Sciences and the National Research Council of the U.S.A. released their report on 'HZE particle effects in manned spaced flight', it has been emphasized how difficult - if not even impossible - it is to assess their radiobiological impact on man from conventional studies where biological test organisms are stochastically exposed to 'large' fluences of heavy ions. An alternative, competing approach had been realized in the BIOSTACK experiments, where the effects of single cosmic as well as accelerator - heavy ions on individual biological test organisms could be investigated. Although presented from the beginning as the preferable approach for terrestrial investigations with accelerator heavy ions too ('The BIOSTACK as an approach to high LET radiation research'), only recently this insight is gaining more widespread recognition. In space flight experiments, additional constraints imposed by the infrastructure of the vehicle or satellite further impede such investigations. Restrictions concern the physical detector systems needed for the registration of the cosmic heavy ions' trajectories as well as the biological systems eligible as test organisms. Such optimized procedures and techniques were developed for the investigations on chromosome aberrations induced by cosmic heavy ions in cells of the stem meristem of lettuce seeds (*Lactuca sativa*) and for the investigation of the radiobiological response of *Wolffia arriza*, which is the smallest flowering (water) plant. The biological effects were studied by the coworkers of the Russian Institute of Biomedical Problems (IBMP) which in cooperation with the European Space Agency ESA organized the exposure in the Biosatellites of the Cosmos series. Since biological investigations and physical measurements of particle tracks had to be performed in laboratories widely separated, the preferred fixed contact between biological test objects and the particle detectors until the geometrical correlation between tracks and organisms has been established could not be maintained. This gave rise to half a dozen of coordinate systems for different measurements which finally had to be related to a single stack reference system. Derived from text

**N95-32731\*#** Justus Liebig-Univ., Giessen (Germany). Cell and Radiation Biophysics.

**X-RAY-PROVOKED NON-MENDELIAN TRANSGENERATIONAL ONCODETERMINANTS**

A. ANDERS, C. FLEMING, H. SCHNEIDER, H. GROEGER, E. SCHNEIDER, J. KIEFER, and F. ANDERS *In* NASA. Ames Research Center, Minutes of the 12th Joint NASA/DARA-DLR Life Sciences Program Working Group Meeting p 41-46 1994  
 Avail: CASI HC A02/MF A03

Cancer is the most important risk of radiation exposure. There is a definite lack of suitable test systems, human epidemiological data are only available for certain radiation types, especially not for charged particles. We use the *Xiphophorus* model which is genetically well characterized. As a prelude to experiments with heavy ions we report here on results obtained with x-rays to establish the necessary baseline for future studies. Apart from this direct aim we hope to obtain also a better insight in the genetical determination of cancer formation. Derived from text

**N95-32901** Colorado Univ., Boulder, CO.

**EFFECTS OF GRAVITY AND LIGHT ON PLANT GROWTH AND PERFORMANCE IN NORMAL AND REDUCED GRAVITY Ph.D. Thesis**

ALEXANDER HOEHN 1993 307 p  
 Avail: Univ. Microfilms Order No. DA9423497

Microgravity enables studies of fundamental processes in gravitational biology not possible on Earth. Biological systems are affected directly through gravity-dependent functions in the organ-

ism as well as indirectly through microgravity-induced changes in the environment. Microgravity plant growth experiments were conducted using spaceflight hardware developed at the University of Colorado. Seedling development was investigated during five space shuttle missions and was similar for ground and space tests. Indications of reduced growth in spaceflight were found in older, dark-grown seedlings (greater than 5 days). Younger plants (less than 3 days) indicated accelerated growth in space when compared to ground controls. Reduced gravity effects on moisture distribution around plant roots and on the output of incandescent lamps were also investigated. Plant lighting in closed space environments is difficult due to power and heat removal limitations. Stringent safety requirements have to be fulfilled for the human spaceflight environments currently used for orbital plant growth payloads. Light-emitting diodes, LEDs, are a promising alternative for future plant lighting systems because of useful safety, life time, and wavelength characteristics. Currently, only red LEDs provide efficiencies and intensities suitable for plant horticulture use. The narrow spectral output of the LEDs raised questions about plant responses under such lighting conditions. Subsequent growth, using custom-built LED arrays, indicated that additional blue light in the order of 5-10 W/sq m (20-40 micromol photons m(exp -2) s(exp -1)) will be required for nominal plant development. The possible replacement of gravitropic stimulation through phototropism in a reduced gravity environment also was investigated. Earth based experiments using one and two-axis clinostats supplemented microgravity plant growth tests, conducted both in light and darkness. The lack of an adequate plant growth system for longer-term plant growth studies in space led to the definition, design, and manufacturing of the Plant-Module for Autonomous Space Support, P-MASS. P-MASS is designed for a 30 day mission aboard the recoverable COMET-1 payload capsule. A new plant growth facility is being designed as a space shuttle middeck-locker payload, addressing many of the needs identified during plant growth experiments described herein. Adequate lighting systems, two phase fluid handling and atmospheric control are essential for a useful spaceflight horticulture capability. Dissert. Abstr.

**N95-33232#** Royal Inst. of Tech., Stockholm (Sweden). Dept. of Mathematics.

**MATHEMATICAL METHODS APPLIED TO BIOTECHNICAL PROCESSES**

JORGE MARI Dec. 1994 106 p  
(ISSN 0348-405X)

(PB95-212114; TRITA-MAT-94-43) Avail: CASI HC A06/MF A02

This work describes how to set up models for biotechnical processes and how to study the resulting characteristics from a mathematical viewpoint in order to facilitate the optimization of the processes. A yeast growth process is the main application example. Special care is taken in showing how model reduction techniques may be applicable, and in which way parameter identification may be performed. The optimization of fed-batch processes is studied from a theoretical, numerical and experimental perspective. Finally the role of computer simulations is also exhibited. NTIS

**N95-33236#** Stockholm Environment Inst., Stockholm (Sweden). **CLEARING-HOUSE MECHANISM TO PROMOTE AND FACILITATE TECHNICAL AND SCIENTIFIC COOPERATION UNDER THE UN CONVENTION ON BIOLOGICAL DIVERSITY** A. ROSEMARIN 1994 55 p Conference held in Nassau, Bahamas, 22-23 Nov. 1994  
(PB95-214557; ISBN-91-88714-05-5) Copyright Avail: CASI HC A04/MF A01

The objective of the Convention on Biological Diversity is the conservation of germplasm, both in situ and ex situ and the sustainable use of biological diversity in a similar manner. Its access to technologies and other development, marketing and financial expertise that will assure mutually equitable arrangements are promoted. These establishment of a clearing house mechanism to promote

and facilitate technical and scientificco-operation is envisaged under Article 18 of the Convention on Biodiversity. NTIS

**N95-33654#** Lawrence Livermore National Lab., Livermore, CA. **PLASMA MEDIATED ABLATION OF BIOLOGICAL TISSUES WITH ULTRASHORT LASER PULSES**

A. A. ORAEVSKY (Rice Univ., Houston, TX.), L. B. DASILVA, M. D. FEIT, M. E. GLINSKY, B. M. MAMMINI, K. L. PAQUETTE, M. D. PERRY, A. M. RUBENCHIK, W. SMALL, IV, and B. C. STUART 8 Mar. 1995 10 p Presented at the SPIE 1995: SPIE Conference on Optics, Electro-optics, and Laser Application in Science, Engineering and Medicine, San Jose, CA, 4-10 Feb. 1995 Submitted for publication  
(Contract(s)/Grant(s): W-7405-ENG-48)  
(DE95-011748; UCRL-JC-120215; CONF-950226-39) Avail: CASI HC A02/MF A01

Plasma mediated ablation of collagen gels and porcine cornea was studied at various laser pulse durations in the range from 350 fs to 1 ns at 1,053 nm wavelength. A time resolved stress detection technique was employed to measure transient stress profiles and amplitudes. Optical microscopy was used to characterize ablation craters qualitatively, while a wide band acoustic transducer helped to quantify tissue mechanical response and the ablation threshold. The ablation threshold was measured as a function of laser pulse duration and linear absorption coefficient. For nanosecond pulses the ablation threshold was found to have a strong dependence on the linear absorption coefficient of the material. As the pulse length decreased into the subpicosecond regime the ablation threshold became insensitive to the linear absorption coefficient. The ablation efficiency was found to be insensitive to both the laser pulse duration and the linear absorption coefficient. High quality ablation craters with no thermal or mechanical damage to surrounding material were obtained with 350 fs laser pulses. The mechanism of optical breakdown at the tissue surface was theoretically investigated. In the nanosecond regime, optical breakdown proceeds as an electron collisional avalanche ionization initiated by thermal seed electrons. These seed electrons are created by heating of the tissue by linear absorption. In the ultrashort pulse range, optical breakdown is initiated by the multiphoton ionization of the irradiated medium (6 photons in case of tissue irradiated at 1,053 nm wavelength), and becomes less sensitive to the linear absorption coefficient. The energy deposition profile is insensitive to both the laser pulse duration and the linear absorption coefficient. DOE

**N95-34789#** Analytic Sciences Corp., San Antonio, TX. **ULTRASHORT PULSE LASER EFFECTS IN THE PRIMATE EYE Interim Report, Mar. 1993 - Jun. 1994**

CLARENCE P. CALN, GARY D. NOOJIN, DAVID J. STOLARSKI, CYNTHIA A. TOTH, and CHERYL D. DICARLO Nov. 1994 121 p Limited Reproducibility: Document partially illegible  
(Contract(s)/Grant(s): F33615-92-C-0017)

(AD-A295024; AL/OE-TR-1994-0141) Avail: CASI HC A06/MF A02

Minimum visible lesion (MVL) threshold measurements at the retina for rhesus monkey eyes are reported for femtosecond, picosecond, and nanosecond single laser pulses using visible wavelengths. Estimates of the dose causing 50% probability for damage (ED50) are calculated for 1-hour and 24-hours postexposure as well as the 95% fiducial intervals for ED. The ED values are found to be dependent on both wavelength and pulsewidth, and for a single wavelength are, in general, lower for short pulsewidths, with the exception of values at the shortest pulsewidth of 90 fs at 580 nm. At 90 fs the ED(50) dosages were noted to increase slightly when compared with the 3-ps and 600-fs values, all three delivered at 580-nm wavelength. The 4-ns ED(50) value was more than double the value at 60 ps delivered at 532-nm wavelength. Fluorescein angiography was accomplished at 1-hour and 24-hours postexposure and did not demonstrate lower threshold for damage, which has been the case for MVL's created with longer pulse duration (greater than 1 ns) or for rabbit eyes at the same pulse-widths as measured in our laboratory. DTIC

## AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**A95-96594**

**SAMPLE PREPARATION METHOD IN SPECTROSCOPIC INVESTIGATIONS OF LASER RADIATION ACTION ON BLOOD AND MARROW**

V. I. KOCHUBEI Saratov State Univ, Saratov, Russia, B. A. MEDVEDEV, YU. G. SEDOVA, and V. YU. STEPANOVA Optics and Spectroscopy (English translation of Optika i Spektroskopiya) (ISSN 0030-400X) vol. 76, no. 5 May 1994 p. 766-768 refs (BTN-94-EIX94441385675) Copyright

Absorption spectra of blood and marrow were investigated in dynamics during storage in media characterized by various medium-preservative-buffer proportions and different preservatives used. It was shown that stability of the spectra is highest if the medium is diluted using an isotonic solution with the addition of Trilon B. Preliminary experiments aimed at comparison of laser action on blood and marrow were carried out. Author (EI)

**A95-96595**

**LASER FLUORESCENCE SPECTROSCOPY OF HUMAN SKIN IN VIVO: THE EFFECT OF ERYTHEMA**

S. R. UTTS Saratov State Univ, Saratov, Russia, YU. P. SINICHKIN, and E. A. PILIPENKO Optics and Spectroscopy (English translation of Optika i Spektroskopiya) (ISSN 0030-400X) vol. 76, no. 5 May 1994 p. 771-774 refs (BTN-94-EIX94441385677) Copyright

Results are reported that demonstrate the necessity of accounting for erythema as a factor capable, of distorting the in vivo autofluorescence spectra of skin. Author (EI)

**N95-32419\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**CHARACTERIZATION OF MICROGRAVITY EFFECTS ON BONE STRUCTURE AND STRENGTH USING FRACTAL ANALYSIS**

RAJ S. ACHARYA (State Univ. of New York, Buffalo, NY.) and LINDA SHACKELFORD In its National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1994, Volume 1 15 p Jul. 1995

Avail: CASI HC A03/MF A03

The effect of micro-gravity on the musculoskeletal system has been well studied. Significant changes in bone and muscle have been shown after long term space flight. Similar changes have been demonstrated due to bed rest. Bone demineralization is particularly profound in weight bearing bones. Much of the current techniques to monitor bone condition use bone mass measurements. However, bone mass measurements are not reliable to distinguish Osteoporotic and Normal subjects. It has been shown that the overlap between normals and osteoporosis is found for all of the bone mass measurement technologies: single and dual photon absorptiometry, quantitative computed tomography and direct measurement of bone area/volume on biopsy as well as radiogrammetry. A similar discordance is noted in the fact that it has not been regularly possible to find the expected correlation between severity of osteoporosis and degree of bone loss. Structural parameters such as trabecular connectivity have been proposed as features for assessing bone conditions. In this report, we use fractal analysis to characterize bone structure. We show that the fractal dimension computed with MRI images and X-Ray images of the patella are the same. Preliminary experimental results show that the fractal dimension computed from MRI images of vertebrae of human subjects before bedrest is higher than during bedrest. Author

**N95-32611** Hopital A. Beclere, Clamart (France). Lab. d'Explorations Fonctionnelles.

**NONINVASIVE DETERMINATION OF CARDIAC OUTPUT Final Report [EVALUATION NON-INVASIVE DU DEBIT CARDIAQUE]**

P. ESCOURROU and M. JAFFRIN Jan. 1994 24 p In FRENCH Prepared in cooperation with Universite de Technologie de Compiègne, France. Sponsored by Direction des Recherches, Etudes et Techniques, Paris, France. Centre de Documentation de l'Armement

(Contract(s)/Grant(s): DRET-91-1215-A)

(PB95-208310) Avail: Issuing Activity (National Technical Information Service (NTIS))

Cardiac output (CO) is an important determinant of the hemodynamic homeostasis during stress conditions. To measure the variations in CO, we applied the pulse contour analysis method to blood pressure derived from the Finapres (Ohmeda). Several circulatory models have been compared for the determination of CO from an aortic micromanometer and from the Finapres. Significant correlations were obtained with mean CO values derived by thermodilution during catheterization. An acquisition system has been implemented on a personal computer (PC) for the determination of CO changes during sleep in sleep apnea syndrome and periodic leg movements. This noninvasive tool may be used to evaluate cardiovascular status during stress conditions such as orthostatism, acceleration, hyperthermia, hypovolemia, or stable exercise.

NTIS

**N95-32666#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.

**A NOVEL APPROACH TO THE PROBLEM OF HIGHLY-SENSITIVE REGULAR ANALYSIS FOR MAN-MADE PLUTONIUM IN ENVIRONMENT AND HUMAN BODY**

Y. T. CHUBURKOV, V. P. PERELYGIN, I. ZVARA, Z. SZEGLOWSKI, S. P. SHTANKO, G. V. BUKLANOV, Y. P. KHARITONOV, A. G. BELOV, T. P. DROBINA, V. N. BUGROV et al. 1994 8p Submitted for publication in Radiochimica Acta (DE95-620764; JINR-E-6-94-357) Avail: CASI HC A02/MF A01 (US Sales Only)

A method of determining subpicogram quantities of plutonium in soil, mud, water, plant and animal tissues is proposed. Plutonium is chemically isolated from the samples, while the (alpha)-active Pu-236 is issued to control yield. The plutonium fraction deposited on some backing as well as an uranium containing standard are put in contact with solid state track detectors (SSTD) - foils of polyethyleneterephthalate, and irradiated by thermal neutrons of approximately 10(exp 15)/sq cm fluence. After an appropriate chemical etching, the content of Pu-239 in the samples is determined by scanning fission fragment tracks in the SSTD. To control possible uranium impurities in the plutonium fraction, the latter and the standard (in contact with a fresh SSTD) are bombarded by a high fluence of (gamma)-quanta with energies (less than or equal to) 25 MeV (microtron Bremsstrahlung). We have succeeded in determining the lower limit of U-235 impurities at a level of less than 10(exp -13) g, due to similar photofission cross section of all Pu isotopes. The proposed method provides the determination of Pu-239 content in routine analysis with a sensitivity at a level of 10(exp -13) g/g. More than one hundred assays for Pu-239 content in specimens of above indicated media from Ukraine, Belorussia, Ural region and Germany have been performed. In future, one will hopefully reach a sensitivity of 10(exp -14) - 10(exp -15) g/g. DOE

**N95-33200#** Uniformed Services Univ. of the Health Sciences, Bethesda, MD. School of Medicine.

**TOXIN-MEDIATED TRANSFER AND EXPRESSION OF GENES IN NERVE CELLS Final Report, 3 Jan. 1991 - 30 May 1994**

GREGORY P. MUELLER 12 Oct. 1994 17 p Prepared in cooperation with Maryland Univ., Baltimore, MD.

(Contract(s)/Grant(s): ARO-MIPR-122-93)

(AD-A290501; ARO-27890.1-LS) Avail: CASI HC A03/MF A01

This research sought to determine the feasibility of using receptor-mediated gene transfer as a mechanism for introducing the

expression of foreign genes in nerve cells. DNA carrier systems were constructed using neuronal ligands that are rapidly internalized by receptor-mediated endocytosis. These proteins, principally wheat germ agglutinin and tetanus toxin C-fragment, were complexed with high expression reporter genes and applied to nerve cells in vitro, and administered in vivo into rats. Uptake and expression of the reporter genes were analyzed by standard enzymatic and histochemical procedures. While we have demonstrated, for the first time, that cells in brain can internalize and express plasmid DNA, there is no evidence that this process can be made specific through the introduction of a receptor-mediated mechanism. The findings indicate that: (1) receptor-mediated uptake and expression does occur in the central nervous system (CNS), and (2) lysosomal degradation is probably not the underlying basis for our inability to observe expression. From this it may be concluded that receptor-mediated uptake is not an efficient means for directing the expression of foreign genes in nerve cells in vivo. DTIC

**N95-34052#** Royal Air Force Inst. of Aviation Medicine, Farnborough (England).

**NEGATIVE TO POSITIVE GZ ACCELERATION TRANSITION**

A. R. J. PRIOR In AGARD, Current Concepts on G-Protection Research and Development 8 p May 1995

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Sustained negative Gz acceleration is an uncommon stress; it is poorly tolerated by the pilot, the airframe is normally stressed to only -3 Gz, and operationally there is no defined advantage for performing such a maneuver. However, during repeated pulls of high +Gz it is common practice to push negative Gz while regaining aircraft energy prior to another high G turn. During the period of negative G, which might be for only 1 or 2 seconds, there is the rapid development of bradycardia, peripheral vasodilation, and the likelihood of cardiac arrhythmias. In this physiological state the pilot then pulls positive G giving rise to profound changes in cerebral perfusion and a marked reduction in G tolerance. The use of anti-G trousers reduces the magnitude of this effect but there remains a significant lowering of G tolerance which, it is suggested, might contribute to the genesis of G-induced loss of consciousness. Author

**N95-34056#** Air Force Inst. of Aviation and Space Medicine, Moscow (Russia).

**INCREASE OF HIGH-SUSTAINED +G(Z) TOLERANCE AT THE EXPENSE OF PILOT'S WORKING POSTURE CHANGE**

G. P. STUPAKOV and M. N. KHOMENKO In AGARD, Current Concepts on G-Protection Research and Development 12 p May 1995

Copyright Avail: CASI HC A03/MF A02

This lecture summarizes practical experience and results of theoretical investigations in the field of anti-Gz protection of flyer in high performance fighter-aircraft. The physiological and ergonomical issues are examined of implementation in aerospace flying practice of the anti-G variable geometry seat, which is aimed at the prophylaxis of adverse effects of high sustained, rapid onset rate longitudinal (+Gz), lateral (Gy), and combined (Gz/Gy) accelerations. Presented are the results of estimation of protective efficiency for variable geometry seat, received at multiple centrifuge tests, as well as its advantages with reference to prolonged flights, which were discovered in ground flight simulator experiments. There are elucidated the main physiological particularities of effects of lateral Gy and combined (Gz/Gy) aerial combat maneuvering accelerations. The applicability of variable geometry reclining seat is verified for prevention of some deleterious effects of hypergravitation of flyer's organism. Significant role is shared to physiologo-hygienic aspects of flyer's articulate seat in context with arrangement scheme for flight cabin workstation in high performance fighter aircraft. Author

**N95-34057#** Department of the Air Force, Brooks AFB, TX.  
**NEW ADVANCES IN PHYSIOLOGICAL MEASUREMENTS DURING HIGH-G: TECHNOLOGY**

ULF I. BALLDIN In AGARD, Current Concepts on G-Protection Research and Development 10 p May 1995

Copyright Avail: CASI HC A02/MF A02

New noninvasive techniques for measuring cardiovascular parameters have been introduced to the acceleration research in centrifuge and in flight in fighter aircraft. Transcranial Doppler blood flow velocity measurements have been used in the centrifuge to detect brain blood flow changes during high G. As probe movements during high G is a problem, a remote control probe system has been developed and tested for better accuracy. Infrared spectrophotometry has been tested during increased G, but further development is required. Ear opacity blood volume measurements of circulatory endpoints during high G has been re-introduced. The use of Finapres or similar equipment to measure finger blood pressure has shown to be a very effective tool in acceleration research, both in the centrifuge and in flight, when used properly. Impedance plethysmography has also shown to be a useful tool in acceleration research. Doppler ultrasound blood flow measurements and echocardiography are difficult to use at high G-level, if new robotic techniques are not developed. Subjective scales for ratings of perceived exertion during testing of G-protecting measures or during centrifuge fatigue studies seem to be valuable tools in acceleration research and may help to avoid the need for maximal tests in the centrifuge and thereby discomfort and injuries. Author

**N95-34058#** Defence and Civil Inst. of Environmental Medicine, North York (Ontario).

**METHODS FOR MEASURING PHYSIOLOGICAL RESPONSES AND PROTECTION IN MAN EXPOSED TO HIGH +G(Z)**

F. BUICK, E. H. WOOD (Mayo Foundation, Rochester, MN.), M. PECARIC, and J. MALOAN In AGARD, Current Concepts on G-Protection Research and Development 15 p May 1995

Copyright Avail: CASI HC A03/MF A02

The often-used subjective measurements of +Gz tolerance are inadequate because they are prone to subjective bias and cannot document the time-dependent changes in the reacting physiology. This lecture describes noninvasive, objective measurements used to measure the human subject's physiological status, to monitor physiological reactions in order to compare the +Gz protective value of various +Gz countermeasures, and to measure endpoints which will guide the termination of +Gz exposure. Author

**N95-34472#** New York Univ. Medical Center, New York, NY.

**MEASUREMENT AND REGULATION OF CENTRAL NORADRENERGIC RECEPTORS Final Report, 1 Dec. 1991 - 30 Nov. 1994**

ERIC A. STONE, SANIL J. MNCLIN, and YI ZHANG 30 Nov. 1994 5 p

(Contract(s)/Grant(s): F49620-92-J-0084)

(AD-A294065; AFOSR-95-0338TR) Avail: CASI HC A01/MF A01

Progress was made in a number of areas related to the role of the central noradrenergic system in the behavioral effects of stress. First we established that norepinephrine mediates the persistent anxiety after stress as other have found in various learning paradigms thus linking studies of stress to studies of learned anxiety. Second we showed that a likely factor in this effect is the stimulation of the gene, c-fos, which we found to be stimulated throughout the brain by the noradrenergic system during stress. Third we discovered a new phenomenon caused by stress involving a transient reduction in arousal which causes animals to lose caution in dangerous situations and may be related to temporary desensitization of the brain beta-1 adrenoceptor. Fourth we found that repeated stress in mice causes a progressive decline in nocturnal activity and feeding thus establishing a new animal model of depression which will facilitate studies of the role of the noradrenergic system in behavioral depression. DTIC

**N95-34564#** Air Force Occupational Measurement Center, Randolph AFB, TX.

**AEROSPACE PHYSIOLOGY AFSC 4M0X1**

Mar. 1995 110 p

(AD-A294839; AFPT-90-4M0-028) Avail: CASI HC A06/MF A02



## BEHAVIORAL SCIENCES

This is an Air Force Occupational Measurement Squadron occupational survey report (OSR) of the Aerospace Physiology (AFSC 4M0X1) career ladder. This survey, completed in 1994, is intended to update the current data base and to identify any changes that may have taken place since the last survey in 1988. The AFMAN 36-2108 Specialty Description for this career field states that 3- and 5-skill level members conduct training and testing with aerospace physiology devices. This includes delivering briefings to trainees before hypobaric and hyperbaric chamber flights and dives, as well as acting as inside and outside observer or other related crew positions. Related duties involve instructing and supervising trainees in fitting, adjusting, and caring for oxygen masks and other personal equipment; and briefing students on parasail and proper parachuting techniques, to include landing-fall procedures, swing landing trainer procedures, and parasail procedures. Finally, these personnel maintain and modify aerospace physiology equipment and associated records. DTIC

**N95-34573#** Naval Postgraduate School, Monterey, CA.  
**MANAGING TECHNOLOGICAL CHANGE IN A MILITARY TREATMENT FACILITY: A CASE STUDY OF MEDICAL DIAGNOSTIC IMAGING SUPPORT (MDIS) SYSTEM M.S. Thesis**

LAURA S. TILLERY Dec. 1994 187 p  
(AD-A294894) Avail: CASI HC A09/MF A02

Picture archiving and communication system (PACS) represents an enormously expensive technological innovation in digital imaging which has the potential to alter the way in which radiology is practiced. The purpose of this thesis is to provide a better understanding of the requirements for PACS technology and the implementation of information systems in medical facilities. The objective of PACS technology is to improve access to radiographic images and reports throughout medical facilities while decreasing the cost of image production and storage. Medical Diagnostic Imaging Support (MDIS) system is the military tri-service project to install PACS in selected U.S. military medical treatment facilities (MTF) in an attempt to create a totally filmless environment. This thesis includes a case study of the implementation of the MDIS system at Madigan Army Medical Center and the change management issues that surround the introduction of an information system in a health care organization. The issues brought forth in this study are derived from two change models in the implementation of information systems. DTIC

**N95-34754#** Baylor Coll. of Medicine, Houston, TX.  
**IMMUNOLOGICAL PROTECTION AGAINST BOTULINUM NEUROTOXIN BY A SYNTHETIC VACCINE**

M. Z. ATASSI 10 Apr. 1995 27 p  
(Contract(s)/Grant(s): DAMD17-93-C-3159)  
(AD-A294146) Avail: CASI HC A03/MF A01

Botulism due to food toxin is caused mainly by seven known serotypes of protein neurotoxins, botulinum neurotoxins (BoNt) produced by clostridium botulinum. BoNts are the most potent toxins and poisons known. The purpose of this work is to design a synthetic peptides vaccine for protection against BoNt. Regions of BoNt/A will be selected for synthesis, based on a number of sequence and conformational parameters and their immunological activities towards anti-BoNt/A antibodies and T cells determined. The immunodominant epitopes will be used as immunogens and those peptides which stimulate BoNt/A-cross reactive antibody and/or T cell responses will then be investigated for their capacity to provide active and passive immunity against BoNt/A challenge. The epitopes that are most protective when employed individually as immunogens will be used, in a mixture and in a multiepitope-carrier conjugate, as a vaccine for both active and passive protection of mice. The synthetic vaccine against BoNt/A will be used as a prototype to prepare synthetic vaccines containing the regions of the other serotypes that are counterparts to the regions found to be most protective on BoNt/A. DTIC

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N95-32422\*#** Mount Holyoke Coll., South Hadley, MA. Dept. of Biological Sciences.

**THE ROLE OF THE VESTIBULAR SYSTEM IN MANUAL TARGET LOCALIZATION Final Report**

SUSAN R. BARRY and S. ALYSSA MUELLER In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1994, Volume 1 14 p Jul. 1995 (Contract(s)/Grant(s): NGT-44-005-803)  
Avail: CASI HC A03/MF A03

Astronauts experience perceptual and sensory-motor disturbances during spaceflight and immediately after return to the 1-g environment of Earth. During spaceflight, sensory information from the eyes, limbs and vestibular organs is reinterpreted by the central nervous system so that astronauts can produce appropriate body movements in microgravity. Alterations in sensory-motor function may affect eye-head-hand coordination and, thus, the crewmember's ability to manually locate objects in extrapersonal space. Previous reports have demonstrated that crewmembers have difficulty in estimating joint and limb position and in pointing to memorized target positions on orbit and immediately postflight. One set of internal cues that may assist in the manual localization of objects is information from the vestibular system. This system contributes to our sense of the body's position in space by providing information on head position and movement and the orientation of the body with respect to gravity. Research on the vestibular system has concentrated on its role in oculo-motor control. Little is known about the role that vestibular information plays in manual motor control, such as reaching and pointing movements. Since central interpretation of vestibular information is altered in microgravity, it is important to determine its role in this process. This summer, we determined the importance of vestibular information in a subject's ability to point accurately toward a target in extrapersonal space. Subjects were passively rotated across the earth-vertical axis and then asked to point back to a previously-seen target. In the first paradigm, the subjects used both visual and vestibular cues for the pointing response, while, in the second paradigm, subjects used only vestibular information. Subjects were able to point with 85 percent accuracy to a target using vestibular information alone. We infer from this result that vestibular input plays a role in the spatial programming of manual responses. Author

**N95-34053#** Air Force Inst. of Aviation and Space Medicine, Moscow (Russia).

**SELECTION AND SPECIAL PHYSIOLOGICAL TRAINING OF FLYING PERSONNEL TO HIGH +G(Z)-MANEUVERABLE FLIGHTS-MAIN CONCEPT**

G. P. STUPAKOV and M. N. KHOMENKO In AGARD, Current Concepts on G-Protection Research and Development 15 p May 1995

Copyright Avail: CASI HC A03/MF A02

For insurance of the complete and efficient protection of flyers from exposure of high-sustained and rapid onset rate +Gz-acceleration profiles, together with administration of modern sophisticated counter-G technical appliances, individual physiological tolerance of flyer to the effects of high level Gz stress plays an important role. The necessity of practical implementation of methods of determination of Gz acceleration tolerance to high-sustained +Gz-stress for selection are verified, along with carrying-out of special physiological preparation of flyers in order to magnify their tolerance to such effects. The results of study are presented of health and special physiological preparedness on pilot's individual tolerance to high-sustained +Gz-accelerations. The procedure and criteria of determination of pilot's ability to tolerate high level +Gz-accelerations in

centrifuge tests for selection to transition and mastering the high performance fighter-aircraft of type MiG-29 and SU-27 are disclosed. The possibility of individual pilot's tolerance to high sustained +Gz-acceleration prediction is proved, based on data of statoergometric functional loading test on special physical trainer 'Statoergometer'. For enhancement of flyers' tolerance to high-sustained +Gz-acceleration the complex of means and ways of special physiological preparation involves carrying-out of ground and simulator training, course of physical training exercises on special trainers, realization of training centrifugation runs, and special inflight training in aerobatic sorties. The methodological particularities of carrying-out and efficiency of various kinds of above mentioned special preparation of flyer are analyzed and the probable prospective ways of its further improvement are discussed.

Author

**N95-34059#** German Air Force, Koenigsbrueck (Germany). Inst. of Aviation Medicine.

#### **SELECTION AND TRAINING OF MiG-29 AND FUTURE FIGHTER PILOTS**

H. WELSCH In AGARD, Current Concepts on G-Protection Research and Development 10 p May 1995

Copyright Avail: CASI HC A02/MF A02

With the reunification on 3 Oct. 1990 the German Air Force took possession not only of 24 MiG-29 modern fighter aircraft, but also of the human centrifuge at Koenigsbrueck near Dresden, Saxony. Until now the MiG-29 is the only high performance fighter aircraft of the German Air Force whose pilots need training in a human centrifuge in accordance with the STANAG 3827. The Office of the Surgeon General GAF took the occasion to generate a new basic program for the German Air Force (GAF) not only for the few pilots of the MiG-29, but for the future fighter pilot generation. The program includes the preselection of young pilot candidates on a voluntary basis to exclude candidates without normal physiological cardiovascular reflexes against acceleration forces, the training of student pilots of fighter aircraft before starting fighter pilot school, and the training and qualification program for fighter pilots, for flying the MiG-29 fighter aircraft or other high performance aircraft such as F-16, F-18, and Mirage 2000 as exchange pilots in the USAF, the CAF, or in France.

Author

**N95-34356#** Navy Personnel Research and Development Center, San Diego, CA.

#### **EVENT-RELATED POTENTIALS AND ELECTROENCEPHALOGRAMS IN ADAPTIVE OPERATOR TRAINING: RATIONALE AND ANNOTATED BIBLIOGRAPHY Interim Report, 1 Oct. 1992 - Mar. 1993**

LEONARD J. TREJO, MICHELLE MULLANE, and JAIMEE STEWART May 1995 55 p

(AD-A294337; NPRDC-TN-95-3) Avail: CASI HC A04/MF A01

This report presents summaries of research on physiological metrics of learning and memory, task performance, attention, imagery, mental workload, and adaptive training. The focus of the report is on the potential for physiological metrics such as electroencephalograms and event-related potentials to serve as control variables in adaptive operator training. An adaptive training system could use such variables to adapt the frequency and difficulty of training so as to accelerate learning and enhance transfer of training to real-world environments. This report also describes problems in learning and performance of Navy tasks that call for research on adaptive operator training. Such problems include the complexity of current combat systems, individual differences in learning strategies and ability, and poor transfer of training using conventional training methods. An example of how adaptive training could apply to Navy training is developed for the emitter classification task performed by Navy electronic warfare operators.

DTIC

**N95-34463#** Hartford Univ., CT.

#### **LOCUS OF CONTROL AND COPING STYLE AS STRESS**

#### **MODERATORS IN ACHIEVEMENT ORIENTED INDIVIDUALS M.S. Thesis**

DOUGLAS S. MULBURY May 1995 78 p

(AD-A294275) Avail: CASI HC A05/MF A01

The effects of achievement motivation, locus of control orientation and preferred coping style were investigated for their relationship with subjects reported stress symptoms. Scales for each of these variables were administered to 100 Psychology students at the University of Hartford. The results of these self-reports were analyzed using zero-order correlations and multiple regression analysis. It was predicted that the overall multiple regression coefficient would be significant, as well as the joint effects of locus of control orientation, achievement motive, and preferred coping style on subjects reported stress symptoms. The results indicated a lack of relationship between the independent variables and the dependent variable. An external locus of control orientation was significantly related to higher stress scores and lower achievement orientation. Higher achievement orientation was positively related to the use of active coping styles. Male subjects were slightly but significantly more internally oriented in terms of locus of control than female subjects. The findings were intended to refute the usefulness of the Type A Personality construct in predicting stress-related illness. There is evidence that there are stress moderators that may buffer high achievers from the adverse effects of stress but the relationship is complex and tenuous.

DTIC

**N95-34609#** University of Southern Illinois, Springfield, IL. School of Medicine.

#### **CONCEPTUAL UNDERSTANDING AND STABILITY, AND KNOWLEDGE SHIELDS FOR FENDING OFF CONCEPTUAL CHANGE Final Report, 1988 - 1991**

PAUL J. FELTOVICH, RAND J. SPIRE (Illinois Univ., Urbana-Champaign, IL.), RICHARD L. COULSON, and JANS F. ADAMI 31 Dec. 1994 83 p

(Contract(s)/Grant(s): N00014-88-K-0077)

(AD-A293555; TR-7) Avail: CASI HC A05/MF A01

The paper reports on the learning of difficult and complex concepts, the characteristics of these concepts that make them difficult for students to learn and understand well, the kind of misconceptions they acquire, and the difficulty of changing these misbeliefs. Mental maneuvers (knowledge shields) learners engage to ward off changing their beliefs are presented and discussed.

DTIC

**N95-34610#** Massachusetts Inst. of Tech., Cambridge, MA. Research Lab. of Electronics.

#### **THE VIRTUAL SAILOR: SYNTHETIC HUMANS FOR VIRTUAL ENVIRONMENTS Final Technical Report, 15 Aug. 1992 - 14 Aug. 1993**

DAVID L. ZELTZER 20 Apr. 1995 192 p

(Contract(s)/Grant(s): N00014-92-J-4005)

(AD-A293560) Avail: CASI HC A09/MF A02

In many virtual environment (VE) applications, e.g., a VE system for training personnel to perform multiperson maintenance tasks, the VE system must be able to display accurate models of human figures that can perform routine behaviors and adapt to events in the virtual world. In order to achieve such adaptive, task level interaction with virtual actors, it is necessary to model elementary human motor skills. SkillBuilder is a software system for constructing a set of motor behaviors for a virtual actor by designing motor programs for arbitrarily complicated skills. Motor programs are modeled using finite state machines, and we have categorized a set of transition and ending conditions. Using inverse kinematics and automatic collision avoidance, we use SkillBuilder to construct a suite of behaviors for simulating visually guided reaching, grasping, and head/eye tracking motions for a kinematically simulated actor consisting of rigid body parts. All of these actions have been successfully demonstrated in real-time by permitting the user to interact with the virtual environment using a whole-hand input device.

DTIC



**N95-34774\*#** Embry-Riddle Aeronautical Univ., Daytona Beach, FL.

#### **CERTIFICATION OF TRAINING**

**RICHARD S. GIBSON** *In its Human Factors Certification of Advanced Aviation Technologies* p 137-141 1994  
 Avail: CASI HC A01/MF A04

Training has been around as an informal process for countless years. Most higher order animals require some level of training in hunting, social skills, or other survival related skills to continue their existence beyond early infancy. Much of the training is accomplished through imitation, trial and error, and good luck. In some ways the essentials of training in aviation have not deviated from this original formula a great deal. One of the major changes in aviation and other technical areas is that more complex response chains based on a broader base of knowledge are now required. 'To certify' means many things according to the American Heritage dictionary of the English Language. These meanings range from 'to guarantee as meeting a standard' to 'to declare legally insane'. For this discussion, we will use the definition 'an action taken by some authoritative body that essentially guarantees that the instruction meets some defined standard'. In order to make this certification, the responsible body subjects the educational process, training, training device, or simulator to some type of examination to determine its adequacy or validity. Author

**N95-34775\*#** Civil Aviation Administration (Sweden).

#### **PRESENTATION OF A SWEDISH STUDY PROGRAM CONCERNING RECRUITMENT, SELECTION AND TRAINING OF STUDENT AIR TRAFFIC CONTROLLERS: THE MRU PROJECT PHASE 1**

**RUNE HAGLUND** *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL Human Factors Certification of Advanced Aviation Technologies* p 143-161 1994  
 Avail: CASI HC A03/MF A04

The Director of the ANS Department has set up an objective for the efficiency of screening and training procedures for air traffic controller students which implies that all students admitted 'shall be considered to have the qualification for - and be given the means of - completing the training'. As a consequence, a study project has been established. It is run by the ANS Department with members from the Swedish CAA, in close cooperation with Uppsala University. Author

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## **MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT**

Includes human engineering; biotechnology; and space suits and protective clothing.

**A95-96246**

#### **SIMPLE MODEL FOR HUMAN ARM REACHABLE WORKSPACE**

**JADRAN LENARCIC** Inst Jozef Stefan, Ljubljana, Slovenia and **ANDREJA UMEK** *IEEE Transactions on Systems, Man and Cybernetics* (ISSN 0018-9472) vol. 24, no. 8 August 1994 p. 1239-1246 refs  
 (BTN-94-EIX94522407598) Copyright

The paper introduces a simplified mathematical model of the human arm kinematics which is used to determine the workspace related to the reachability of the wrist. The model contains six revolute degrees of freedom, five in the shoulder complex and one in the elbow joint. It is not directly associated to the anatomical structure of the arm, but represents the spatial motion of two characteristic points, epicondylus lateralis and proc. styloideus. Use of this simplified model for the determination of reachable workspace offers several advantages versus direct measurement: (i) the workspace can be obtained in few minutes on a micro VAX II computer, (ii) patients with various injuries in various stages of recovery can be treated since only a few brief and simple measure-

ments of model's parameters are needed, and (iii) the calculated workspace includes complete information of the envelope, as well as inside characteristics. Author (EI)

**N95-32428\*#** Tulane Univ., New Orleans, LA. Dept. of Mechanical Engineering.

#### **BICYCLE ERGOMETER INSTRUMENTATION TO DETERMINE MUSCLE AND BONE FORCES DURING EXERCISE Final Report**

**FERNANDO FIGUEROA** *In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1994, Volume 1* 14 p Jul. 1995  
 (Contract(s)/Grant(s): NGT-44-055-803)  
 Avail: CASI HC A03/MF A03

It is hypothesized that bone loss experienced by astronauts in zero gravity conditions may be curtailed by appropriate exercise. According to Wolf's law, bone regenerates when muscles produce stresses by pulling on the bone during daily activity and/or exercise on Earth. to use this theory to prevent or decrease bone loss, one needs to quantify musculoskeletal loads and relate them to bone density changes. In the context of the space program, it is desirable to determine musculoskeletal loads during exercise (using the bicycle ergometer in this case) so that one may make similar measurements on Earth and in space. In this manner, load measurements on Earth may be used as reference to generate similar loads during exercise in space. The work reported in this document entails a musculoskeletal load measurement system that, when complete, will provide forces at muscle insertion points and other contact points, on bone. This data will be used by Dr. Beth A. Todd, who is also a SSF working with Dr. Shackelford, as input to a finite element model of bone sections to determine stress distributions. A bicycle ergometer has been instrumented to measure parameters needed to determine musculoskeletal forces during exercise. A primary feature of the system is its compactness. It uses small/light sensors without line-of-sight requirements. The system developed includes sensors, signal processing, a data acquisition system, and software to collect the data. The sensors used include optical encoders to measure position and orientation of the pedal (foot), accelerometers to determine kinematic parameters of the shank and thigh, load cells to measure pedal forces on the sagittal plane, and EMG probes to measure muscle activity. The signals are processed using anti-aliasing filters and amplifiers. The sensors' output is digitized using 30 channels of a board mounted inside a 486 class PC. A program sets the data acquisition parameters and collects data during a time period specified by the user. The data is put directly into a file on the hard disk in binary form. The 30 channels are sampled at 200 KHz, and each 30 channel scan is done at a rate of 1000 Hz. The instrumented ergometer has been flown in the KC-135 zero-gravity (zero-g) flight to collect information needed to determine musculoskeletal forces under these conditions. Similar information has been collected in 1-g conditions for comparison with the results from the zero-g case. At this time, the sets of data from both experiments are being processed. An existing methodology will be used to determine the kinematic parameters of the shank and thigh using accelerometer and encoder data. This methodology was developed during the fellow's previous NASA/ASEE fellowship and thanks to a Director's Grant. In the future, a methodology to determine the musculoskeletal forces using Newton's Law of Motion and optimization techniques will be developed to determine forces exerted by particular muscles. Author

**N95-32489#** Naval Air Warfare Center, China Lake, CA. Targeting Systems Integration Section.

#### **MULTISPECTRAL IMAGE CORRELATION FOR AIR-TO-GROUND TARGETING**

**W. R. DITZLER, M. J. BOYD, T. J. CORCORAN, M. S. FRANKLIN, J. E. MCKNIGHT, H. C. OTTENHOFF, R. W. TYHURST, and M. M. WIRTZ** *In AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations* 12 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

A primary cause of failure in tactical air-to-ground missions is the the aircrew fails to find the assigned target. This is the case even for missions against preassigned, large, stationary targets, such as bridges, supply depots, and air-defense sites, for which reconnaissance and satellite images of the target and its surroundings are available for the mission planning process. An important reason for this poor performance is the limited time available for target acquisition, especially when target defences necessitate low-level ingress. During the time a target is visible to aircraft sensors, the aircraft is also visible to the target's defense systems. The time required for air-to-ground targeting with present systems (for example, to lock a targeting FLIR onto an aimpoint is comparable to the response time of air defense systems. Clearly, minimizing the time needed to find and recognize targets is crucial for making attack missions more survivable. Survivability is enhanced if the attack mission can be carried out without the need to 'pop up' to use a targeting sensor. In a typical low-level attack mission, 8-10 s is available for the targeting process, from appearance of the target to weapon release. However, a pilot cannot remove his attention from flying the aircraft for this length of time, especially at night using night-vision systems. Pilots who have tested night-vision systems for low-level flight estimate that 1.5-2.0 s is the maximum allowable time to concentrate on a head-down display under these conditions. A near-term solution to the targeting problem must let the human operator make the final decision. The system described in this paper automates the search for the target (or an offset aimpoint) by sending video from one or more of the aircraft sensors to an image correlator. The correlator finds the best match to an image of the target area, supplied from mission planning data, and displays the resulting target position overlaid on the sensor image. The aircrew is required to look at a head-down display only long enough to confirm or deny the correlator's result. The correlator can then automate the process of locking an image missile seeker onto target. Derived from text

**N95-32504#** Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan (Italy).

**SIRPH: STEERABLE INFRARED PICTURE ON HELMET MOUNTED DISPLAY**

GIORGIO BALZAROTTI, LORENZO FIORI, and BEATRICE MIDOLLINI In AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations 10 p Jan. 1995

Copyright Avail: CASI HC A02/MF A03

Helmet Mounted Displays (HMD's) are being paid remarkable attention as an essential aid to pilots of both fixed and rotary wing aircraft: The technological improvements such equipment are experiencing place them in an outstanding position among avionics. A very important role in the success of HMD's is played by the management of man-machine-interface aspects: The way to make the information available, in a useful format, to the pilot must be considered with particular care. A smart example is the presentation of images from steerable sensors: The head tracking systems have actually achieved a high degree of accuracy, thus allowing a precise control of the Line Of Sight (LOS) of electrooptical vision systems. Therefore, pictures generated by a steerable infrared sensor slaved to the pilot's head movements can be displayed onto the helmet visor, in order to provide the pilot with a substantial aid in day and night, adverse weather conditions, high altitudes down to low level and nap of the earth flight operations. The paper describes the results of a technical analysis performed on a system based on a steerable IR sensor integrated with an advanced HMD for navigation aid purposes. The parameters which lead to an imperfect static or dynamic overlay of the generated IR picture with the external world, as seen by the pilot through the helmet visors, and the effects of such misalignment are analyzed in detail, together with integration aspects and human engineering factors. The analysis has also taken into account the finite angular excursion of the IR sensor LOS, originated by gimbals limits, and the consequent necessary transition to and from the LLTV's integrated within the helmet, suitable to cover all possible head motions, has

been investigated. An approach to the problem of the fusion of information generated by the IR sensor and the LLTV's is also reported. Finally, the paper highlights the limits and the constraints of navigation using a steerable IR sensor, with respect to safety aspects. Author

**N95-32535#** Lawrence Livermore National Lab., Livermore, CA. **FUNCTIONAL REQUIREMENTS ANALYSIS AND HUMAN MACHINE INTERFACE SPECIFICATIONS FOR HANDHELD METAL DETECTOR WANDS**

V. HOANG, C. HARTNEY, and W. BANKS Nov. 1994 110 p (Contract(s)/Grant(s): W-7405-ENG-48)

(DE95-009845; UCRL-CR-119401) Avail: CASI HC A06/MF A02 Functional Requirements Analysis (FRA) and Human-Machine-Interface Design Specifications (HMD's) are critical elements in the development of effective security systems. Handheld metal detector wands are currently used by security personnel to detect metal weapons and munitions that might be smuggled onboard an aircraft by terrorists or individuals who intend to do harm to passengers, aircraft, or other air carrier-related targets. The FAA has requested that Lawrence Livermore National Laboratory (LLNL) assist in developing functional requirements for handheld metal detector devices (wands) used at airports. This effort is focused on both defining and assuring adequate functional and human interface designs that are an integral part of airport security operations. In addition to developing functional requirements, LLNL was also requested to examine and review wand procedures currently used by the airports and air carriers and provide comments, recommendations, and suggestions for enhanced security based upon this review. The phrase 'Human-Machine-Interface' (HMI) is frequently used to describe the characteristics of a system that allows the human to interact and control the machine or system. Equipment used by checkpoint security Pre-Board Screeners (PBS's) during rapid search of passengers must be designed to fit a broad range of anthropometric differences in height, hand size, grip strength, upper body strength, visual acuity, auditory acuity, and other related human variables. In essence, if there is a high degree of compatibility between the end-user and the equipment, there will be a direct enhancement of total system performance and system operability. Thus, this document may also be used as, a guideline to enhance ergonomic compatibility between the PBS's and the equipment they use. DOE

**N95-32688\*#** California Univ., Los Angeles, CA. Dept. of Chemical Engineering.

**MULTIOBJECTIVE OPTIMIZATION OF HYBRID REGENERATIVE LIFE SUPPORT TECHNOLOGIES. TOPIC D: TECHNOLOGY ASSESSMENT Progress Report**

VASILIOS MANOUSIOUTHAKIS May 1995 27 p

(Contract(s)/Grant(s): NAG2-822)

(NASA-CR-199125; NAS 1.26:199125) Avail: CASI HC A03/MF A01

We developed simple mathematical models for many of the technologies constituting the water reclamation system in a space station. These models were employed for subsystem optimization and for the evaluation of the performance of individual water reclamation technologies, by quantifying their operational 'cost' as a linear function of weight, volume, and power consumption. Then we performed preliminary investigations on the performance improvements attainable by simple hybrid systems involving parallel combinations of technologies. We are developing a software tool for synthesizing a hybrid water recovery system (WRS) for long term space missions. As conceptual framework, we are employing the state space approach. Given a number of available technologies and the mission specifications, the state space approach would help design flowsheets featuring optimal process configurations, including those that feature stream connections in parallel, series, or recycles. We visualize this software tool to function as follows: given the mission duration, the crew size, water quality specifications, and the cost coefficients, the software will synthesize a water recovery system for the space station. It should require minimal user intervention. The following tasks need to be solved for achieving this goal:

(1) formulate a problem statement that will be used to evaluate the advantages of a hybrid WRS over a single technology WBS; (2) model several WRS technologies that can be employed in the space station; (3) propose a recycling network design methodology (since the WRS synthesis task is a recycling network design problem, it is essential to employ a systematic method in synthesizing this network); (4) develop a software implementation for this design methodology, design a hybrid system using this software, and compare the resulting WRS with a base-case WRS; and (5) create a user-friendly interface for this software tool. Author

**N95-33139#** Moscow Inst. of Aviation Technology (USSR). Simulators and Pilot-Vehicle Lab.

**DEVELOPMENT AND APPLICATION OF THE METHODS FOR PILOT-AIRCRAFT SYSTEM RESEARCH TO THE MANUAL CONTROL TASKS OF MODERN VEHICLES**

A. V. EFREMOV and A. V. OGLOBLIN In AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control 12 p Mar. 1995

Copyright Avail: CASI HC A03/MF A02

There are discussed the influence of some typical for the modern vehicles features (high frequency phase delay and nonlinearities in flight control system (FCS)) and parameters of input spectral density corresponding to the real piloting tasks on pilot response characteristics. There are developed some new standard characteristics the optimal aircraft dynamics and discomfort frequency response, and demonstrated their efficiency for the several applied tasks in design of FCS and development of requirements to the handling qualities. There are discussed the ways for suppression of pilot limitation parameters and FCS nonlinear and phase delay effects. Derived from text

**N95-33237#** National Defence Research Establishment, Stockholm (Sweden). Dept. of Human Sciences.

**STIMULUS-RESPONSE COMPATIBILITY**

BENGT BERGSTROEM Dec. 1994 19 p

(ISSN 0014-9154)

(PB95-214722; FOA-R-94-00077-5.2-SE) Avail: CASI HC A03/MF A01

A critical relation in a man-machine system is the operator-workstation interface. The present report reviews the stimulus-response compatibility aspect of this interface. Three kinds of compatibility are recognized: display-control, control-display, and display-central process-control relations. Empirical principles of display-control and control-display compatibility are described. Display-central process-control relations are discussed using a multiple-resource model of information processing. The report concludes with recommendations aimed at system designers and users. NTIS

**N95-33312** Virginia Univ., Charlottesville, VA.

**THE PRESERVATION OF HUMAN SURROGATES FOR BIOMECHANICAL STUDIES Ph.D. Thesis**

JEFF RICHARD CRANDALL 1994 285 p

Avail: Univ. Microfilms Order No. DA9415549

Preservation procedures for human surrogates were evaluated based on their ability to maintain the mechanical properties of fresh tissues, to simulate the response of living tissues, and to limit the transmittance of infectious diseases. The biomechanical properties of fresh, frozen, and embalmed hard tissues were obtained from three-point bend tests and analyzed using elastic beam theory. The elastic responses and the relaxation functions of preserved soft tissues were determined from indentation testing and viscoelastic models. Based upon the results from mechanical testing of the tissue specimens, preservation techniques for surrogates were adjusted to provide the response of living humans in an impact environment. Compression tests of preserved surrogates were performed and compared with published values for tensed and untensed volunteers. Combining simulation software and dynamic analysis; the sensitivity of human response to tissue condition was characterized in order to demonstrate the utility of using preservation techniques to adjust the physical properties of human surro-

gates. Finally, chromatography procedures estimated the distribution and the concentration of chemical disinfectants within embalmed surrogates. The analysis determined that the concentrations of the preservatives were sufficient to neutralize any infectious viruses or bacteria in the tissues. The mechanical test results, simulation work, and chemical analysis indicate that embalming is the preferential preservation method for human surrogates used in biomechanical studies. Dissert. Abstr.

**N95-33605** Dayton Univ., OH.

**HUMAN PILOTING FACTORS IN THE DESIGN OF CONTROL LAWS FOR PRECISION LANDING Ph.D. Thesis**

DAVID JOHN MOORHOUSE 1993 177 p

Avail: Univ. Microfilms Order No. DA9412549

This research investigates aircraft control law design with two objectives: (1) facilitate precise touchdown through enhanced controllability and (2) improve safety by reducing pilot workload when landing in adverse conditions. Aircraft accidents have happened in windshear conditions that were well within the aircraft performance capability to negotiate safely. A review of such occurrences led to a conviction that pilots were receiving ambiguous response cues. The classical equations of aircraft dynamics were reanalyzed from the viewpoint of how a pilot perceives the dynamic responses and his most likely control response. This new viewpoint shows that an aperiodic phugoid mode resulting from tight glideslope control gives the appearance of losing speed stability. The analyses were extended to combined effects of pilot control inputs and wind gradient effects. It was shown that a major factor in the ambiguity of the piloting cues is the coupling between airspeed and flight path responses. It was postulated, therefore, that a more effective control law design could be achieved by decoupling of the two responses using airspeed as the reference as opposed to the conventional use of angle of attack. The preceding requirement for decoupling of flight path and airspeed responses was implemented in a flight experiment to demonstrate precision touchdown for a fighter aircraft. The flight results validated the concept under a variety of adverse conditions, including an actual windshear encounter. As part of the larger experiment, the decoupled control laws facilitated a precision touchdown at night with no external lighting or guidance aids with very low pilot workload. Additional analyses were performed using the theory of divided attention, with airspeed control considered as a managerial task and glide slope as a compensatory task. This was developed into an 'imperfect pilot' model to quantify the benefits of augmenting the managerial task. Simulation results using the imperfect pilot model were compared with results from an optimal control formulation. The results were shown to be completely different. It is suggested that the two techniques should be used in a complementary fashion for aircraft design. Dissert. Abstr.

**N95-34050#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.

**CURRENT CONCEPTS ON G-PROTECTION RESEARCH AND DEVELOPMENT [CONCEPTS ACTUELS EN RECHERCHE ET DEVELOPPEMENT POUR LA PROTECTION ANTI-G]**

May 1995 128 p Lecture series held in Ohio, 15-16 May 1995, in Koenigsbrueck, Germany, 12-13 Jun. 1995, and in Farnborough, UK, 15-16 Jun. 1995

(AGARD-LS-202; ISBN-92-836-0016-9) Copyright Avail: CASI HC A07/MF A02

A new class of fighter aircraft is emerging that will be operational or in advanced Test and Evaluation (T&E) by 1995. These aircraft (e.g. MiG 31, YF-22, Eurofighter, Rafale) are capable of developing G far in excess of 9G (i.e. 12G will be a realistic capability). The operational envelope of these agile aircraft will depend upon the G protection provided to the aircrew. In response to this challenge, established and new laboratories using human-use centrifuges are developing new aircrew protection methods. These laboratories include Armstrong Laboratory (US), SAM (UK), DCIEM (CA), LAMAS (FR), SAM (RU), KONIGSBRUCK Laboratory (GE) and FOA Laboratory (SW). In 1995, much of this research will

have produced prototype flight-worthy equipment/methods with advanced understanding of their physiological bases. This lecture series reviews (1) pathophysiology of high sustained G (9G and above) and (2) recent equipment development and reports on T&E. For individual titles, see N95-34051 through N95-34060.

**N95-34051#** Armstrong Lab., Brooks AFB, TX. Crew Technology Div.

**G-PROTECTION BASIS/ACCELERATION PHYSIOLOGY**

J. W. BURNS In AGARD, Current Concepts on G-Protection Research and Development 10 p May 1995

Copyright Avail: CASI HC A02/MF A02

Our major objective is to protect the aircrew against the detrimental effects of +Gz by developing and assessing equipment and techniques to enhance high sustained acceleration (+Gz) tolerance, and minimize the hazards of G-LOC. The payoff is reduced pilot fatigue and improved combat effectiveness. To accomplish these objectives it is imperative that we learn as much as possible regarding acceleration physiology and the influence that protective equipment and techniques have on acceleration physiology. Derived from text

**N95-34055#** Royal Air Force Inst. of Aviation Medicine, Farnborough (England).

**POSITIVE PRESSURE BREATHING FOR G PROTECTION (PBG)**

A. R. J. PRIOR In AGARD, Current Concepts on G-Protection Research and Development 16 p May 1995

Copyright Avail: CASI HC A03/MF A02

Modern, high performance, combat aircraft are capable of high sustained +Gz acceleration, at high G onset rates, for which enhanced G protection of the pilot is required if the performance of the aircraft is not to be limited by the capabilities of the pilot. Given that the pilot is essentially seated upright in the cockpit, the most suitable system of enhanced G protection is that of positive pressure breathing (PBG) with the possible addition of new anti-G trousers having considerably greater bladder coverage than previous garments. PBG used with in-service anti-G trousers reduces pilot fatigue and doubles G endurance. An anti-G straining maneuver (AGSM) is still required as the relaxed G tolerance of the pilot is increased by only 1G. PBG used with full or extended coverage anti-G trousers enables the pilot to tolerate 8G without needing to employ the AGSM and provides a high degree of protection against G-induced loss of conscious. However, the increased bladder coverage of the trousers, and that of the chest counterpressure garment which is probably required for PBG, imposes a higher heat load on the pilot and has a tendency to reduce mobility. In addition, the oxygen mask must be capable of effecting an adequate seal of the PBG pressure against the face without user intervention; furthermore the system must be compatible with helmets containing display and sighting systems and be capable of use with NBC protective systems. Development PBG systems have yet to be fully optimized and their routine use by aircrew requires further assessment particularly with regard to the longer term consequences.

Author

**N95-34060#** Department of the Air Force, Brooks AFB, TX. Crew Technology Div.

**G-PROTECTION CAPABILITIES AND CURRENT G-PROTECTION ISSUES**

J. W. BURNS In AGARD, Current Concepts on G-Protection Research and Development 8 p May 1995

Copyright Avail: CASI HC A02/MF A02

Acceleration tolerance and protection of female pilots, relationship between time away from +Gz exposure (G-layoff) and a reduced G tolerance, and +Gz-induced loss of consciousness (G-LOC) are discussed. G tolerance and endurance capabilities are reflections of the pilot's strength. While within gender there is a poor correlation (average 0.2) between body size and strength, males as a group are significantly stronger than females. Current +Gz protective equipment has been designed using male anthropometry. Two modifications were made to the anti-G suit to provide a better fit for

female pilots: (1) a V-shaped dart in the lumbar restraint material to bring the suit in at the waist and (2) a lowered upper edge of the abdominal bladder below the rib cage in the seated position. Anecdotal information suggests a positive relationship between G-layoff and reduced G tolerance. The reduced endurance observed in this study may reflect the reduced +Gz tolerance reported to follow G-layoff, but they are not related to changes in aerobic or anaerobic metabolism, or relaxed responses to +Gz. The anti-G straining maneuver (AGSM) is a major factor in the maintenance of vision and consciousness for most pilots during high levels of +Gz. G-LOC is unique to the flight maneuvering environment in that it occurs in healthy aircrew. It is insidiously dangerous because it can happen with little or no warning. Cessation of cerebral blood flow, kinetics and secondary characteristics, and convulsions during G-LOC are discussed. CASI

**N95-34358#** Naval Air Warfare Center, Patuxent River, MD.

**THE ANVIS HEAD-UP DISPLAY: AN ANALYSIS OF ITS APPLICATION TO NAVAL HELICOPTERS**

DEAN PETERS 28 Feb. 1995 21 p

(AD-A294342) Avail: CASI HC A03/MF A01

Combat Search and Rescue (CSAR) helicopter pilots routinely utilize Night Vision Goggles to enhance visual capabilities during night operations. The Aviator's Night Vision Imaging System (ANVIS) Head-Up Display (HUD), recently tested on the HH-60H Seahawk, provides the capability to display critical flight parameters to the pilots via goggle-mounted display units, thus minimizing head-down time in the cockpit. As more and more naval helicopter missions diversify to include CSAR and CSAR support, devices which effectively enhance night mission pilots. This HUE system and critically analyzes its advantages and limitations for use in Naval helicopters. In addition, ANVIS HUD symbology is examined from a human factors perspective with recommendations for symbology design and placement. DTIC

**N95-34370#** Army Medical Research and Development Command, Fort Detrick, MD.

**TRI-SERVICE PERSPECTIVES ON MICROCLIMATE COOLING OF PROTECTIVE CLOTHING IN THE HEAT**

KENT B. PANDOLF Apr. 1995 207 p

(AD-A294005; USAMRMC-T95-10) Avail: CASI HC A10/MF A03

This Tri-Service report evaluates the effectiveness of various microclimate cooling systems in alleviating the thermal burden imposed on our service members by wearing protective clothing in the heat. The report summarizes the findings from studies involving liquid-cooled, air-cooled, and ice-cooled systems conducted by the U.S. Army, U.S. Navy, and the U.S. Air Force. While both liquid- and air-cooled systems are shown to remove significant quantities of body heat, more evidence seems to favor air-cooled systems. In general, most commercially available microclimate cooling systems are shown not to be operationally suitable for the Services' needs. To date, the ideal microclimate cooling system suitable for most military situations has not been developed or identified. However, prediction modeling analyses indicate that with heat extraction rates of 300-400 watt, microclimate cooling can be a significant force multiplier for the Services in most desert and tropic climates. DTIC

**N95-34376#** Army Research Lab., Aberdeen Proving Ground, MD.

**A COMPARISON OF MONOCULAR, BINOCULAR, AND BINOCULAR NIGHT VISION GOGGLES FOR TRAVERSING OFF-ROAD TERRAIN ON FOOT Final Report**

V. G. CUQLOCK-KNOPP, WARREN TORGERSON, DAWN E. SIPES, EDWARD BENDER, and JOHN O. MERRITT Mar. 1995 47 p

(AD-A294018; ARL-TR-747) Avail: CASI HC A03/MF A01

The performance of humans who traversed off-road terrain while wearing monocular, binocular, and binocular night vision goggles was examined. The difficulties that each of 35 male participants encountered while walking through rough terrain and wearing the three types of goggles were scored by independent observers. Participants themselves also rated several qualities of the goggles

and ranked the goggles overall. In general, results indicated that the binocular goggle yielded better performance and was preferred to the other two goggles and that the binocular and the monocular goggles showed no consistent difference for any of the four sets of dependent measures. DTIC

**N95-34378# Army Aeromedical Research Lab., Fort Rucker, AL. OH-58 PILOT DISPLAY UNIT (PDU) SIMULATED CRASH TESTS Final Report**

JOSEPH L. HALEY, JR. and B. J. MCENTIRE Dec. 1994 54 p  
(Contract(s)/Grant(s): DA PROJ. 301-62787-A-878)  
(AD-A294049; USAARL-95-10) Avail: CASI HC A04/MF A01

The pilot display unit (PDU) is designed to be placed directly in front of the pilot's eyes in the OH-58 helicopter to provide targeting and a missile status display. The location and the 7-pound mass of the unit creates a potentially hazardous head impact surface. In order to determine the degree of the hazard, a damaged OH-58 cockpit section was exposed to five survivable simulated crashes of moderate to severe impact vectors with an instrumented dummy pilot in the right seat behind the PDU. The cockpit floor was exposed to crash force up to 8 G in the vertical (z) axis and 19 G along the longitudinal (x) axis with velocity changes of 24 fps and 36 fps, respectively. These exposures did not exceed acceptable levels of human tolerance for neck and head forces when a properly fitted flight helmet was worn so that impact occurred on the helmet and not the head. DTIC

**N95-34475# Naval Postgraduate School, Monterey, CA. ANIMATION WITHIN A MULTIMEDIA TRAINING SYSTEM FOR NIGHT VISION GOGGLES M.S. Thesis**

SEAN T. EPPERSON Mar. 1995 56 p  
(AD-A294095) Avail: CASI HC A04/MF A01

Night vision goggles (NVG) provide aircrews the ability to perform many daylight operations in the nighttime environment. However, with these enhanced nighttime capabilities many mishaps occur due to aircrews overestimating the capabilities of the goggles. To reduce the risks when using NVG's, increase combat survivability, and increase combat effectiveness, continuous training is needed. A promising training alternative is multimedia. This thesis focuses on the implementation of animation within a computer-based interactive multimedia system to assist in training aircrews who use NVG's. The extent any media such as animation can be implemented to provide effective training through multimedia is largely dependent on adherence to fundamental instructional design principles. This research details the methods and techniques used in the development of animation that is part of the NVG multimedia prototype. Also a description is given of the hardware components and software applications utilized, as well as how the prototype was developed. The findings show that animation is very useful for certain instructional roles and conditions. Animation's most significant uses are in presenting procedural tasks, providing a visual representation of information that cannot be captured by other media, and the principles of operation of NVG's. DTIC

**N95-34489# Army Aeromedical Research Lab., Fort Rucker, AL. EVALUATING THE POTENTIAL FOR ROTATION AND LOSS OF FLIGHT HELMETS FROM INERTIA AND IMPACT LOADS Final Report**

JAMES E. BRUCKART and JOSEPH L. HALEY, JR. Mar. 1995 16 p  
(Contract(s)/Grant(s): DA PROJ. 301-62787-A-878)  
(AD-A294041; USAARL-95-20) Avail: CASI HC A03/MF A01

In severe helicopter accidents, flight helmets rotate or sometimes come off the head, triggering wearer injury. This study evaluates rotation potential for new flight helmets. Current and prototype flight helmets (SPH-4B and two versions of the HGU-56) were subjected to three tests. First, rotation was measured with up to a 50-pound upward pull at the rear edge of the helmet on a medium-size headform. Second, angular displacement was measured with a 30-pound force at the side of the helmet. Third, the helmet was placed

on a Hybrid 2 headform and Hybrid 3 neck, then mounted on a pendulum test device. The freefalling pendulum was decelerated to produce 16 to 20 G peak acceleration at the neck. Angular displacement of the helmet versus time was measured with high-speed video. The upward pull tests produced 18 to 33 degrees of helmet rotation. Sideward loads produced 13 to 21 degrees of rotation. The pendulum test produced up to 45 degrees forward and up to 25 degrees rearward displacement. DTIC

**N95-34492# Army Aeromedical Research Lab., Fort Rucker, AL. USER ACCEPTABILITY AND COMFORT OF THE COMMUNICATIONS EARPLUG (CEP) WHEN USED IN THE UH-1 HELICOPTER**

BEN T. MOZO, BARBARA A. MURPHY, and JOHN E. RIBERA Feb. 1995 39 p

(Contract(s)/Grant(s): DA PROJ. 301-6287-A-878)  
(AD-A294047; USAARL-95-17) Avail: CASI HC A03/MF A01

Aviators and crewmembers assigned to the crash rescue (FLATIRON) unit at Fort Rucker, Alabama participated in an evaluation of the communications earplug (CEP) in the aviation environment. They were asked to wear the two CEP configurations in combination with their personal SPH-4 helmet for three flights of at least 1 hour duration. One CEP configuration included a foam tip and the other included a premolded triple flange tip. Comments and responses provided by the volunteers showed the CEP, with some modifications, is acceptable for use in the aviation environment. Speech clarity of the CEP was judged to be an improvement over normal helmet/ear protection by 85 percent of the respondents. The CEP with foam tip was judged to be more comfortable than CEP with the triple flange tip. Comfort was judged to be between comfortable and mildly uncomfortable for the CEP with foam earplug tip. The volunteers rated the CEP as being helpful in achieving their mission. The results of this study show the CEP is comfortable and acceptable to the aviation crewmember. DTIC

**N95-34574# Army Aeromedical Research Lab., Fort Rucker, AL. EVALUATION OF A RETROFIT OH-58 PILOT'S SEAT TO PREVENT BACK INJURY Final Report**

JOSEPH L. HALEY, JR. and RONALD W. PALMER Dec. 1994 87 p  
(AD-A294895; USAARL-95-9) Avail: CASI HC A05/MF A01

This report documents the development of pilot and copilot retrofit seats, flight tests and evaluation of the seats based on crash tests, flight tests, and a 5-year usage test in the USAARL OH-58, serial no. 71-207781. The Bell Helicopter Textron (BHT) designed seat consists of a new seat pan, hinged at the forward edge, and attached to 'load-limit' devices at the rear edge. The seat will rotate about its forward edge mount and move downward approximately 5 inches at the rear edge when the impact sink speed of the helicopter is excessive. The 5-inch stroke of the seat occurs while sustaining approximately 12 G on a 50th percentile pilot (1500-lb maximum in the lower lumbar spine). The seats, mounted in a standard OH-58 fuselage, were subjected to simulated 'sink' speeds of 26.5, 29.6, and 32.2 fps. The seats easily prevented 'injury' to the dummy pilots at 26.5 fps, but the seats 'bottomed' against the cyclic control yoke at greater sink speed. DTIC

**N95-34577# Army Research Inst. of Environmental Medicine, Natick, MA.**

**GENERAL PROCEDURE FOR CLOTHING EVALUATIONS RELATIVE TO HEAT STRESS**

LESLIE LEVINE, MICHAEL N. SAWKA, and RICHARD R. GONZALEZ May 1995 62 p  
(AD-A294953; USARIEM-TN-95-5) Avail: CASI HC A04/MF A01

This technical note (TN) describes the recommended biophysical and physiological test procedures for heat stress evaluations of textiles and clothing. The emphasis in this TN is on the human physiological testing, which is required as part of the development and acquisition process for Army materiel, in support of the Health Hazard Assessment (HHA) which is conducted by the U.S. Army

Center for Health Promotion and Preventive Medicine, provisional. Biophysical evaluations for clothing include determination of the thermal characteristics for textiles via guarded hot plate tests, and for clothing systems via thermal manikin tests. Mathematical models are used to predict performance for evaluation conditions and/or field use. Human physiological testing for clothing is best done in a controlled laboratory environment, although field trials may also be conducted. Tests must control for confounding variables, and proven test and measurement methods must be employed. DTIC

**N95-34616#** Rochester Univ., NY. Dept. of Computer Science. **ADAPTIVE DIFFERENTIAL VISUAL FEEDBACK FOR UNCALIBRATED HAND-EYE COORDINATION AND MOTOR CONTROL** Technical Report  
MARTIN JAGERSAND and RANDAL C. NELSON 14 Dec. 1994 30 p Sponsored by Sverige-Amerika Stiftelsen; and the Fulbright Commission  
(Contract(s)/Grant(s): N00014-93-1-0221)  
(AD-A293607; TR-597) Avail: CASI HC A03/MF A01

We propose and implement a novel method for visual space trajectory planning, and adaptive high degree of freedom (DOF) visual feedback control. The method requires no prior information either about the kinematics of the manipulator, or the placement or calibration of the cameras, and imposes no limitations on the number of degrees of freedom controlled or the number of kind of visual features utilized. The approach provides not only a means of low-level servoing but a means to integrate it with higher level visual space trajectory and task planning. We are thus able to specify and perform complex tasks composed of several primitive behaviors, using both visual servoing and open loop control, where the number of sensed and controlled signals varies during the task. We report experimental results demonstrating a factor of 5 improvement in the repeatability of manipulations using a PUMA arm when comparing visual closed-loop to traditional joint level servoing. We also present experiment statistics showing the advantages of adaptive over nonadaptive control systems, and of using redundant visual information when performing manipulation tasks. Finally, we demonstrate usefulness of the approach by using it to specify and execute complex tasks involving real-world robot manipulation of rigid and nonrigid objects in up to 12 degrees of freedom. The manipulation is performed in the context of a semi-autonomous robot manipulation system. DTIC

**N95-34658** Newcastle-upon-Tyne Univ., Newcastle (England). **ANALYSIS OF SAFETY REQUIREMENTS IN THE CONTEXT OF SYSTEM FAULTS AND HUMAN ERRORS**  
R. DELEMOS, R. FIELDS, and A. SAEED Feb. 1995 27 p Prepared in cooperation with York Univ., England  
(PB95-236105; TRS-504) Copyright Avail: Issuing Activity (National Technical Information Service (NTIS))

The paper describes an approach to the incremental and iterative analysis of requirements for safety-critical systems. The novel feature of the approach is that properties related to users of safety-critical systems are also considered in the analysis. Safety strategies are developed to ensure that hazard states are avoided and the system's integrity is maintained in the presence of failures in the system components. The approach supports an understanding of human error and the formulation of human error tolerance requirements ensuring that safety is preserved in the presence of user errors. The approach is illustrated with an example from the aerospace industry, and complementary safety strategies that allocate functionality to both the pilot and the computing systems are presented. NTIS

**N95-34764\*#** Embry-Riddle Aeronautical Univ., Daytona Beach, FL. Center for Aviation/Aerospace Research. **HUMAN FACTORS CERTIFICATION OF ADVANCED AVIATION TECHNOLOGIES**  
JOHN A. WISE, ed., V. DAVID HOPKIN, ed. (Civil Aviation Authority, Farnborough, England.), DANIEL J. GARLAND, ed., and L. W. HENNESSY, ed. Embry-Riddle Aeronautical Univ. Press 1994 387

p Conference held in Toulouse, France, 19-23 Jul. 1993 Sponsored in cooperation with Eurocontrol, FAA, Direction Generale de l'Aviation Civile, and Research Inst. for Information, Science, and Engineering In Aviation Human Factors Series  
(Contract(s)/Grant(s): NAG1-1593)  
(NASA-CR-199009; NAS 1.26:199009; ISBN-1-884099-03-3) Avail: CASI HC A17/MF A04

Proceedings of the Human Factors Certification of Advanced Aviation Technologies Conference held at the Chateau de Bonas, near Toulouse, France, 19-23 July 1993. For individual titles, see N95-34765 through N95-34787.

**N95-34765\*#** Embry-Riddle Aeronautical Univ., Daytona Beach, FL.

#### **ON THE USE OF THE SYSTEMS APPROACH TO CERTIFY ADVANCED AVIATION TECHNOLOGIES**

MARK A. WISE (University of Central Florida, Orlando, FL.) and JOHN A. WISE *In its Human Factors Certification of Advanced Aviation Technologies* p 15-23 1994  
Avail: CASI HC A02/MF A04

The field of human factors is as varied and diverse as the human subject itself. But one of its most important applications is the facilitation of safety and efficiency in a particular working environment through the implementation of paradigms known about humans and their working relationship with machines and systems. During the period since World War II (which is often viewed as the birth of Human Factors) no area has been the subject of more human factors research than aviation. And in no time during that epoch is the influence of human factors more important, nor more imperative than it is today. As technology driven designs have been finding their way into the national airspace system (NAS), there has been growing concern within the aviation industry itself, the Federal Aviation Administration (FAA), and the general public for a means by which to certify complex systems and the advanced aviation technologies that will be responsible for transporting, directing, and maintaining our airborne travel. While it is widely agreed human factors certification is desirable, the philosophy that will underlie the approach is debatable. There are, in general, two different approaches to certification: (1) the top-down or systems approach; and, (2) the bottom-up or monadical approach. The top-down approach is characterized by the underlying assumption that certification can be best achieved by looking at the system as a whole, understanding its objectives and operating environment, then examining the constituent parts. In an aircraft cockpit, this would be accomplished by first examining what the aircraft is supposed to be (e.g., fighter, general aviation, passenger), identifying its operating environment (IFR, VMC, combat, etc.) and looking at the entire working system which includes the hardware, software, liveware and their interactions; then, evaluative measures can be applied to the subsystems (e.g., individual instruments, CRT displays, controls). The bottom-up approach is founded on the philosophy that the whole can be best served by first examining its constituent elements. This approach would perform the above certification completely antithetically, by looking at the individual parts and certifying good human factors applications to those parts under the basic assumption that the whole is equal to the sum of its parts. Author

**N95-34767\*#** Federal Aviation Administration, Washington, DC. **A PSYCHOLOGIST'S VIEW OF VALIDATING AVIATION SYSTEMS**  
EARL S. STEIN and DAN WAGNER *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies* p 46-52 1994  
Avail: CASI HC A02/MF A04

All systems, no matter what they are designed to do, have shortcomings that may make them less productive than was hoped during the initial development. Such shortcomings can arise at any stage of development: from conception to the end of the implementation life cycle. While systems failure and errors of a lesser magnitude can occur as a function of mechanical or software breakdown, the majority of such problems, in aviation are usually laid on the shoulders of the human operator and, to a lesser extent,



on human factors: The operator bears the responsibility and blame even though, from a human factors perspective, error may have been designed into the system. Human factors is not a new concept in aviation. The name may be new, but the issues related to operators in the loop date back to the industrial revolution of the nineteenth century and certainly to the aviation build-up for World War I. During this first global confrontation, military services from all sides discovered rather quickly that poor selection and training led to drastically increased personnel losses. While hardware design became an issue later, the early efforts were primarily focused on increased care in pilot selection and on their training. This actually involved early labor-intensive simulation, using such devices as sticks and chairs mounted on rope networks which could be manually moved in response to control input. The use of selection criteria and improved training led to more viable person-machine systems. More pilots survived training and their first ten missions in the air, a rule of thumb arrived at by experience which predicted ultimate survival better than any other. This rule was to hold through World War II. At that time, personnel selection and training became very sophisticated based on previous standards. Also, many psychologists were drafted into Army Air Corps programs which were geared towards refining the human factor. However, despite the talent involved in these programs and the tremendous build-up of aviation during the war, there were still aircraft designs that were man killers (no sexism implied since all combat pilots were men). One classic design error that was identified fifty years ago was the multipointer altimeter, which could easily be misread especially by a pilot under considerable task load. It has led to flying fully operational aircraft into the terrain. The authors of the research which formally identified this problem put 'Human Errors' in quotes to express their dissatisfaction with the traditional approach to accident investigation. It traditionally places the burden of guilt on the operator. Some of these altimeters still exist in older aircraft to this day. Author

**N95-34768\*# Eurocontrol Experimental Centre, Bretigny (France).  
CERTIFICATION OF TACTICS AND STRATEGIES IN  
AVIATION**

HARTMUT KOELMAN *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 54-75 1994*

Avail: CASI HC A03/MF A04

The paper suggests that the 'tactics and strategies' notion is a highly suitable paradigm to describe the cognitive involvement of human operators in advanced aviation systems (far more suitable than classical functional analysis), and that the workload and situational awareness of operators are intimately associated with the planning and execution of their tactics and strategies. If system designers have muddled views about the collective tactics and strategies to be used during operation, they will produce sub-optimum designs. If operators use unproven and/or inappropriate tactics and strategies, the system may fail. The author wants to make a point that, beyond certification of people or system designs, there may be a need to go into more detail and examine (certify?) the set of tactics and strategies (i.e., the Operational Concept) which makes the people and systems perform as expected. The collective tactics and strategies determine the information flows and situational awareness which exists in organizations and composite human-machine systems. The available infrastructure and equipment (automation) enable these information flows and situational awareness, but are at the same time the constraining factor. Frequently, the tactics and strategies are driven by technology, whereas we would rather like to see a system designed to support an optimized Operational Concept, i.e., to support a sufficiently coherent, cooperative and modular set of anticipation and planning mechanisms. Again, in line with the view of MacLeod and Taylor (1993), this technology driven situation may be caused by the system designer's and operator job designer's over-emphasis on functional analysis (a mechanistic engineering concept), at the expense of a subject which does not seem to be well understood

today: the role of the (human cognitive and/or automated) tactics and strategies which are embedded in composite human-machine systems. Research would be needed to arrive at a generally accepted 'planning theory' which can elevate the analysis, description and design of tactics and strategies from today's cottage industry methods to an engineering discipline. The available infrastructure and equipment (automation) enable these information flows and situational awareness, but are at the same time the constraining factor. Frequently, the tactics and strategies are driven by technology, whereas we would rather like to see a system designed to support an optimized Operational Concept, i.e., to support a sufficiently coherent, cooperative and modular set of anticipation and planning mechanisms. Again, in line with the view of MacLeod and Taylor (1993), this technology driven situation may be caused by the system designer's and operator job designer's over-emphasis on functional analysis (a mechanistic engineering concept), at the expense of a subject which does not seem to be well understood today: the role of the (human cognitive and/or automated) tactics and strategies which are embedded in composite human-machine systems. Research would be needed to arrive at a generally accepted 'planning theory' which can evaluate the analysis, description and design of tactics and strategies from today's cottage industry methods to an engineering discipline. Author

**N95-34769\*# Eurocontrol Experimental Centre, Bretigny (France).  
HUMAN FACTORS CERTIFICATION: A USEFUL CONCEPT?  
ALISTAIR JACKSON *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 79-86 1994***

Avail: CASI HC A02/MF A04

This paper considers what is involved in certification processes and their relation to human factors aspects of systems. It derives from recognition of a lack of understanding of the processes and purposes of certification. This was encountered when attempting to address the workshop topic by integrating an understanding of human factors with the observed processes of certification. The paper considers what human factors (HF) certification might be and then develops a simple model of the elements of a certification process. It then tries to relate these elements to the needs of the aviation communities and other parties with an interest in the certification of advanced aviation technologies. Author

**N95-34773\*# Search Technology, Inc., Norcross, GA.  
CERTIFY FOR SUCCESS: A METHODOLOGY FOR HUMAN-  
CENTERED CERTIFICATION OF ADVANCED AVIATION  
SYSTEMS**

RONALD L. SMALL and WILLIAM B. ROUSE *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 127-133 1994*

Avail: CASI HC A02/MF A04

This position paper uses the methodology in Design for Success as a basis for a human factors certification program. The Design for Success (DFS) methodology espouses a multi-step process to designing and developing systems in a human-centered fashion. These steps are as follows: (1) naturalizing - understand stakeholders and their concerns; (2) marketing - understand market-oriented alternatives to meeting stakeholder concerns; (3) engineering - detailed design and development of the system considering tradeoffs between technology, cost, schedule, certification requirements, etc.; (4) system evaluation - determining if the system meets its goal(s); and (5) sales and service - delivering and maintaining the system. Because the main topic of this paper is certification, we will focus our attention on step 4, System Evaluation, since it is the natural precursor to certification. Evaluation involves testing the system and its parts for their correct behaviors. Certification focuses not only on ensuring that the system exhibits the correct behaviors, but ONLY the correct behaviors. Author

**N95-34776\*#** Aerosystems International, Yeovil (England).

**DOES HUMAN COGNITION ALLOW HUMAN FACTORS (HF) CERTIFICATION OF ADVANCED AIRCREW SYSTEMS?**

IAIN S. MACLEOD and ROBERT M. TAYLOR (Royal Air Force Inst. of Aviation Medicine, Farnborough, England.) *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 163-186 1994*

Avail: CASI HC A03/MF A04

This paper has examined the requirements of HF specification and certification within advanced or complex aircrew systems. It suggests reasons for current inadequacies in the use of HF in the design process, giving some examples in support, and suggesting an avenue towards the improvement of the HF certification process. The importance of human cognition to the operation and performance of advanced aircrew systems has been stressed. Many of the shortfalls of advanced aircrew systems must be attributed to over automated designs that show little consideration on either the mental limits or the cognitive capabilities of the human system component. Traditional approaches to system design and HF certification are set within an over physicalistic foundation. Also, traditionally it was assumed that physicalistic system functions could be attributed to either the human or the machine on a one to one basis. Moreover, any problems associated with the parallel needs, or promoting human understanding alongside system operation and direction, were generally equated in reality by the natural flexibility and adaptability of human skills. The consideration of the human component of a complex system is seen as being primarily based on manifestations of human behavior to the almost total exclusion of any appreciation of unobservable human mental and cognitive processes. The argument of this paper is that the considered functionality of any complex human-machine system must contain functions that are purely human and purely cognitive. Human-machine system reliability ultimately depends on human reliability and dependability and, therefore, on the form and frequency of cognitive processes that have to be conducted to support system performance. The greater the demand placed by an advanced aircraft system on the human component's basic knowledge processes or cognition, rather than on skill, the more insidious the effects the human may have on that system. This paper discusses one example of an attempt to devise an improved method of specification and certification with relation to the advanced aircrew system, that of the RN Merlin helicopter. The method is realized to have limitations in practice, these mainly associated with the late production of the system specification in relation to the system development process. The need for a careful appreciation of the capabilities and support needs of human cognition within the design process of a complex man machine system has been argued, especially with relation to the concept of system functionality. Unlike the physicalistic Fitts list, a new classification of system functionality is proposed, namely: (1) equipment - system equipment related; (2) cognitive - human cognition related; and (3) associated - necessary combination of equipment and cognitive. This paper has not proposed a method for a fuller consideration of cognition within systems design, but has suggested the need for such a method and indicated an avenue towards its development. Finally, the HF certification of advanced aircrew systems is seen as only being possible in a qualified sense until the important functions of human cognition are considered within the system design process. (This paper contains the opinions of its authors and does not necessarily reflect the standpoint of their respective organizations).

Author

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**PRACTICAL GUIDELINES FOR WORKLOAD ASSESSMENT**

ANDREW J. TATTERSALL *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 193-206 1994*

Avail: CASI HC A03/MF A04

The practical problems that might be encountered in carrying out workload evaluations in work settings have been outlined. Different approaches have been distinguished that may determine

the type of research design used and provide assistance in the difficult choice between workload assessment techniques. One approach to workload assessment is to examine the short-term consequences of combining various tasks. Theoretical models of attention allocation will underpin specific studies of interference and the consequences of task demand and task conflict for performance. A further approach with a different temporal orientation may lead us to a better understanding of the relationships between work demands and strain through the analysis of individual differences in cognitive control processes. The application of these processes may depend on individual differences in long term styles and short term strategies, but may be used to prevent decrements in work performance under difficult conditions. However, control may attract costs as well as benefits in terms of changes in effective state and physiological activity. Thus, strain associated with work demands may only be measurable in the form of tradeoffs between performance and other domains of individual activity. The methodological implications are to identify patterns of adjustment to workload variations using repeated measures and longitudinal sampling of performance as well as subjective and physiological measures. Possible enhancements to workplace design must take into account these human factors considerations of workload in order to avoid potential decrements in individual performance and associated organizational problems.

Author

**N95-34778\*#** University of Eastern Michigan, Ypsilanti, MI.  
**IS THERE A ROLE FOR A TEST CONTROLLER IN THE DEVELOPMENT OF NEW ATC EQUIPMENT?**

RON WESTRUM *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 221-228 1994*

Avail: CASI HC A02/MF A04

Earl Wiener points out that human factors problems fixed during the R & D stage are paid for once. When they are not fixed during R & D, they are then paid for every day. How users are involved in the R & D process to assist in developing equipment is a critical issue. Effective involvement can produce real improvements. Ineffective involvement can produce inefficient kludges or systems that are actually dangerous. The underlying problem is the management of information and ideas. To develop a really generative system a great deal would have to change in the way that the FAA innovates. Use of test controllers would solve only some of the problems. For instance, we have cockpit resource management now for pilots; we may have it soon for controllers. But the management of ideas in the innovation process also needs intellectual resource management. Simply involving users is not enough. Brought in at the wrong point in the development process, users can block or compromise innovation. User involvement must be carefully considered. A test controller may be one solution to this problem. It might be necessary to have several kinds of test controllers (en route versus TRACON, for instance). No doubt further problems would surface in getting test controllers into operation. I would recommend that the FAA engage in a series of case studies of controller involvement in the innovation process. A systematic comparison of effective and ineffective cases would do much to clarify what we ought to do in the future. Unfortunately, I have been unable to find any cases where test controllers have been used. Perhaps we need to create some, to see how they work.

Author

**N95-34779\*#** Austrian Road Safety Board (Austria).  
**TOWARDS A FRAMEWORK OF HUMAN FACTORS CERTIFICATION OF COMPLEX HUMAN-MACHINE SYSTEMS**

BIRGIT BUKASA *In Embry-Riddle Aeronautical Univ., Daytona Beach, FL Human Factors Certification of Advanced Aviation Technologies p 229-234 1994*

Avail: CASI HC A02/MF A04

As far as total automation is not realized, the combination of technical and social components in man-machine systems demands not only contributions from engineers but at least to an equal extent from behavioral scientists. This has been neglected far too



long. The psychological, social and cultural aspects of technological innovations were almost totally overlooked. Yet, along with expected safety improvements the institutionalization of human factors is on the way. The introduction of human factors certification of complex man-machine systems will be a milestone in this process. Author

**N95-34780\*#** Baldwin International Services, Heffingen (Luxembourg).

**THE SUCCESSFUL MANAGEMENT OF PROGRAMS FOR HUMAN FACTORS CERTIFICATION OF ADVANCED AVIATION TECHNOLOGIES**

ROD BALDWIN In Embry-Riddle Aeronautical Univ., Daytona Beach, FL Human Factors Certification of Advanced Aviation Technologies p 237-245 1994

Avail: CASI HC A02/MF A04

In recent years there have been immense pressures to enact changes on the air traffic control organizations of most states. In addition, many of these states are or have been subject to great political, sociological and economic changes. Consequently, any new schemes must be considered within the context of national or even international changes. Europe has its own special problems, and many of these are particularly pertinent when considering human factors certification programs. Although these problems must also be considered in the wider context of change, it is usually very difficult to identify which forces are pressing in support of human factors aspects and which forces are resisting change. There are a large number of aspects which must be taken into account if human factors certification programs are to be successfully implemented. Certification programs would be new ventures, and like many new ventures it will be essential to ensure that managers have the skills, commitment and experience to manage the programs effectively. However, they must always be aware of the content and the degree of certainty to which the human factors principles can be applied - as Debons and Home have carefully described. It will be essential to avoid the well known pitfalls which occur in the implementation of performance appraisal schemes. While most appraisal schemes are usually extremely well thought out, they often do not produce good results because they are not implemented properly and staff therefore do not have faith in them. If the manager does not have the commitment and interest in his/her staff as human beings, then the schemes will not be effective. Thus, one aspect of considering human factors certification schemes is within the context of a managed organization. This paper outlines some of the management factors which need to be considered for the air traffic control services. Many of the points received attention during the plenary sessions while others were covered by the working groups when the question arose of how various aspects of human factors certification programs would be managed. Management and organizational issues will certainly need to be included in any frame of reference by those who may be involved in developing certification programs. Author

**N95-34781\*#** Sterling Software, Inc., Dallas, TX.

**EVALUATION IN CONTEXT: ATC AUTOMATION IN THE FIELD**

KELLY HARWOOD and BEVERLY SANFORD In Embry-Riddle Aeronautical Univ., Daytona Beach, FL Human Factors Certification of Advanced Aviation Technologies p 247-262 1994

Avail: CASI HC A03/MF A04

The process for incorporating advanced technologies into complex aviation systems is as important as the final product itself. This paper described a process that is currently being applied to the development and assessment of an advanced ATC automation system, CTAS. The key element of the process is field exposure early in the system development cycle. The process deviates from current established practices of system development — where field testing is an implementation endpoint — and has been deemed necessary by the FAA for streamlining development and bringing system functions to a level of stability and usefulness. Methods and approaches for field assessment are borrowed from human factors engineering, cognitive engineering, and usability engineering and are tailored for the constraints of an operational ATC environment.

To date, the focus has been on the qualitative assessment of the match between TMA capabilities and the context for their use. Capturing the users' experience with the automation tool and understanding tool use in the context of the operational environment is important, not only for developing a tool that is an effective problem-solving instrument but also for defining meaningful operational requirements. Such requirements form the basis for certifying the safety and efficiency of the system. CTAS is the first U.S. advanced ATC automation system of its scope and complexity to undergo this field development and assessment process. With the rapid advances in aviation technologies and our limited understanding of their impact on system performance, it is time we opened our eyes to new possibilities for developing, validating, and ultimately certifying complex aviation systems. Author

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**INTEGRATING HUMAN FACTORS KNOWLEDGE INTO CERTIFICATION: THE POINT OF VIEW OF THE INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)**  
DANIEL MAURINO and VINCENT GALOTTI In Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 264-273 1994

Avail: CASI HC A03/MF A04

It is appropriate here to repeat the analogy described in the introduction to this paper which is that: The consideration of human factors requirements during the design stage of advanced, new technology systems may be seen as resting over a three-legged stool. The first leg, the equipment that a system will utilize to achieve its goals, has traditionally attracted ergonomic considerations associated with equipment design, usually centered around 'knobs and dials.' Lately, this view has expanded to include the so-called other important aspect of Human Factor's study which deals with the cognitive, behavioral and social processes of the human operators. Study in this area must be furthered. The second leg of the stool, the procedures to operate the equipment, however, has been largely unaddressed. Procedures are not inherent to equipment, but must be developed. The importance of proper human factors consideration in the design of procedures can not be overstated. Lastly, the third leg of the stool, the certification of personnel who will operate the equipment, is very much underway, but far from being complete. The real quest now, however, is to integrate these three legs into an indivisible one. Finally, and most importantly, this workshop and its topic are extremely timely in that we are at the dawn of the most ambitious development ever undertaken in international civil aviation. This would allow us the rather unique opportunity to put theory into practice in the near future by ensuring that the concepts developed and furthered by this workshop and the follow-up are implemented in the design and certification of the ICAO future CNS/ATM systems described earlier in this paper. Now is the time to incorporate human factors requirements during the certification processes of these systems. This might act as a test to the feasibility of these ideas. Such endeavors represent a challenge for the research, engineering, training, operational and regulatory communities. But there is certainly more to be gained by attempting to meet the challenge rather than refraining from progress by decrying the difficulties involved. Author

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**IMPROVING AIR TRAFFIC CONTROL: PROVING NEW TOOLS OR APPROVING THE JOINT HUMAN-MACHINE SYSTEM?**

IRENE GAILLARD and MARCEL LEROUX (Centre d'Etudes de la Navigation Aérienne, Toulouse, France.) In Embry-Riddle Aeronautical Univ., Daytona Beach, FL Human Factors Certification of Advanced Aviation Technologies p 275-299 1994

Avail: CASI HC A03/MF A04

From the description of a field problem (i.e., designing decision aids for air traffic controllers), this paper points out how a cognitive engineering approach provides the milestones for the evaluation of future joint human-machine systems. Author

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### **CERTIFICATION FOR CIVIL FLIGHT DECKS AND THE HUMAN-COMPUTER INTERFACE**

ANDREW J. MCCLUMPHA (Royal Air Force Inst. of Aviation Medicine, Farnborough, England.) and MARIANNE RUDISILL *In* Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 289-299 1994

Avail: CASI HC A03/MF A04

This paper will address the issue of human factor aspects of civil flight deck certification, with emphasis on the pilot's interface with automation. In particular, three questions will be asked that relate to this certification process: (1) are the methods, data, and guidelines available from human factors to adequately address the problems of certifying as safe and error tolerant the complex automated systems of modern civil transport aircraft; (2) do aircraft manufacturers effectively apply human factors information during the aircraft flight deck design process; and (3) do regulatory authorities effectively apply human factors information during the aircraft certification process? Author

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### **SOME INADEQUACIES OF THE CURRENT HUMAN FACTORS CERTIFICATION PROCESS OF ADVANCED AIRCRAFT TECHNOLOGIES**

JEAN PARIES *In* Embry-Riddle Aeronautical Univ., Daytona Beach, FL Human Factors Certification of Advanced Aviation Technologies p 301-306 1994

Avail: CASI HC A02/MF A04

Automation related accidents or serious incidents are not limited to advanced technology aircraft. There is a full history of such accidents with conventional technology aircraft. However, this type of occurrence is far from sparing the newest 'glass cockpit' generation, and it even seems to be a growing contributor to its accident rate. Nevertheless, all these aircraft have been properly certificated according to the relevant airworthiness regulations. Therefore, there is a growing concern that with the technological advancement of air transport aircraft cockpits, the current airworthiness regulations addressing cockpit design and human factors may have reached some level of inadequacy. This paper reviews some aspects of the current airworthiness regulations and certification process related to human factors of cockpit design and focuses on questioning their ability to guarantee the intended safety objectives. Author

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### **ADVANCED AUTOMATED GLASS COCKPIT CERTIFICATION: BEING WARY OF HUMAN FACTORS**

RENE AMALBERTI and FLORENCE WILBAUX *In* Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 309-319 1994

Avail: CASI HC A03/MF A04

This paper presents some facets of the French experience with human factors in the process of certification of advanced automated cockpits. Three types of difficulties are described: first, the difficulties concerning the hotly debated concept of human error and its non-linear relationship to risk of accident; a typology of errors to be taken into account in the certification process is put forward to respond to this issue. Next, the difficulties connected to the basically gradual and evolving nature of pilot expertise on a given type of aircraft, which contrasts with the immediate and definitive style of certifying systems. The last difficulties to be considered are those related to the goals of certification itself on these new aircraft and the status of findings from human factor analyses (in particular, what should be done with disappointing results, how much can the changes induced by human factors investigation economically affect aircraft design, how many errors do we need to accumulate before we revise the system, what should be remedied when human factor problems are discovered at the certification stage: the machine? pilot training? the rules? or everything?). The growth of advanced-automated glass cockpits has forced the international

aeronautical community to pay more attention to human factors during the design phase, the certification phase and pilot training. The recent creation of a human factor desk at the DGAC-SFACT (Official French services) is a direct consequence of this. The paper is divided into three parts. Part one debates human error and its relationship with system design and accident risk. Part two describes difficulties connected to the basically gradual and evolving nature of pilot expertise on a given type of aircraft, which contrasts with the immediate and definitive style of certifying systems. Part three focuses on concrete outcomes of human factors for certification purposes. Author

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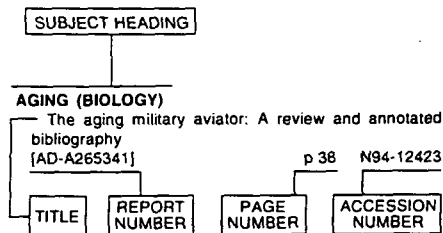
### **BEWARE OF AGENTS WHEN FLYING AIRCRAFT: BASIC PRINCIPLES BEHIND A GENERIC METHODOLOGY FOR THE EVALUATION AND CERTIFICATION OF ADVANCED AVIATION SYSTEMS**

DENIS JAVAUX, MICHEL MASSON, and VERONIQUE DEKEYSER *In* Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Human Factors Certification of Advanced Aviation Technologies p 321-345 1994

Avail: CASI HC A03/MF A04

There is currently a growing interest in the aeronautical community to assess the effects of the increasing levels of automation on pilots' performance and overall safety. The first effect of automation is the change in the nature of the pilot's role on the flight deck. Pilots have become supervisors who monitor aircraft systems in usual situations and intervene only when unanticipated events occur. Instead of 'hand flying' the airplane, pilots contribute to the control of aircraft by acting as mediators, instructions given to the automation. By eliminating the need for manually controlling normal situations, such a role division has reduced the opportunities for the pilot to acquire experience and skills necessary to safely cope with abnormal events. Difficulties in assessing the state and behavior of automation arise mainly from four factors: (1) the complexity of current systems and consequence mode-related problems; (2) the intrinsic autonomy of automation which is able to fire mode transitions without explicit commands from the pilots; (3) the bad quality of feed-back from the control systems displays and interfaces to the pilots; and (4) the fact that the automation currently has no explicit representation of the current pilots' intentions and strategy. Assuming certification has among its major goals to guarantee the passengers' and pilots' safety and the airplane integrity under normal and abnormal operational conditions, the authors suggest it would be particularly fruitful to come up with a conceptual reference system providing the certification authorities both with a theoretical framework and a list of principles usable for assessing the quality of the equipment and designs under examination. This is precisely the scope of this paper. However, the authors recognize that the conceptual presented is still under development and would thus be best considered as a source of reflection for the design, evaluation and certification processes of advanced aviation technologies. Derived from text

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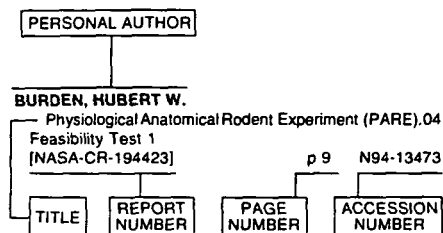
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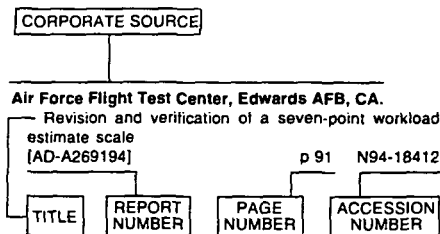
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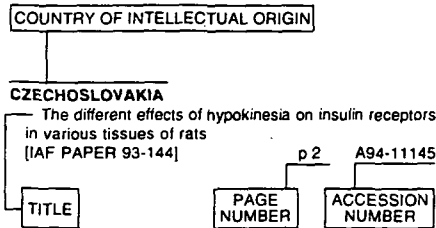


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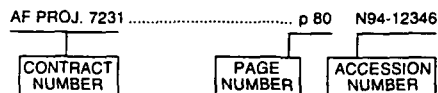
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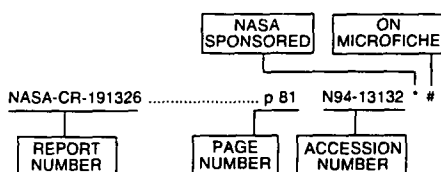
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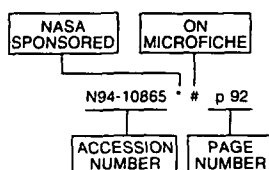
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